New Scientist

WEEKLY 27 January 2024

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SPECIAL ISSUE

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The 7 strangest aspects of your biology – and why they matter

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Brain: The latest science behind the headlines

Join six leading brain scientists on 10 February at London's Conway Hall. By way of the latest research in neuroscience, psychology and physiology, they will reveal what is going on in our heads when we think, feel and communicate. Gain expert insights into how you can boost your cognitive performance and live a healthier, happier life.

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Tour

Rewilding in the Côa valley: Portugal

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newscientist.com/tours

Podcast

CultureLab

NASA astronaut Christina Koch not only took part in the first ever all-female spacewalks, but she also holds the record for the longest single space flight by a woman. Now she has her eyes set on the moon. *New Scientist* space reporter Leah Crane asks Koch what it takes to live in space for such a long time, and how you get used to gravity again when you finally come home.

newscientist.com/nspod

NASA

Record breaker Christina Koch tells all about life on a space station

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Côa valley Diverse nature flourishes in a remote corner of Portugal

Video

Untouched wilderness

New Scientist subeditor Bethan Ackerley interviews Simon Reeve about his new four-part BBC travel documentary, *Wilderness*. Reeve seeks out corners of our rapidly urbanising globe that are relatively untouched by humanity. We need to protect and fight for these wilderness areas, he says, "if we are to have any hope of combating climate change".

youtube.com/newscientist

Newsletter

Carbon scrubbing

Enhanced weathering removes atmospheric carbon dioxide by layering crushed-up rocks over open fields – replicating geological processes over short timescales. *New Scientist* environment reporter James Dinneen finds out if this method can remove enough carbon to help us reach net zero on time.

newscientist.com/fix-the-planet

Newsletter

"The difficulty isn't getting the rocks to the field, but how we can measure the carbon that is captured"

Essential guide

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Ask a silly question

Exploring the peculiarities of human physiology can bring serious benefits

ANCIENT Egyptians would have considered it bizarre to contemplate whether the brain might contain our mind: for them, the heart was the repository for our thoughts and wisdom. Likewise, not so long ago, it would have seemed ridiculous to wonder what the bacteria living in our guts were doing, never mind consider their connection to depression or our ability to fight disease.

Now, of course, we know that our microbiome is vital to both mental and physical health. And although we are still some way off understanding how our brains give rise to consciousness, there can be no doubt that asking questions about the strangest aspects of our physiology can lead to some seriously helpful insights – as we discover in our special feature exploring the mysteries of the human body, starting on page 30.

Most recently, knowledge gained by investigating bacteria that live in the gut has led researchers to question what is going on with the other microbes residing within us. What are all those fungi doing in there (page 32)?

"Investigating the stranger aspects of our biology could open doors to new treatments"

The emerging answer is that, just like the bacteria that call your body home, the fungi living inside you are not only linked with serious infections and some cancers, but can also help prevent common conditions like diarrhoea and thrush. All of which leads to the tantalising possibility that we could one day manipulate them to improve health, just as we are trying to do with gut bacteria.

It is just one example of how questions about what might seem to be irrelevant aspects of our bodies – from why they are so asymmetrical (page 34) and whether we possess pheromones (page 35) to why we have cells from siblings inside us (page 33) and what taste buds are doing in testicles (page 36) – are more valuable than we think.

Investigating such peculiarities can reveal fresh insights into our evolutionary past, open doors to new treatments and even change how we think about what it is to be human. So we should encourage more bizarre inquiries – the answers they throw up are rarely silly. ▮

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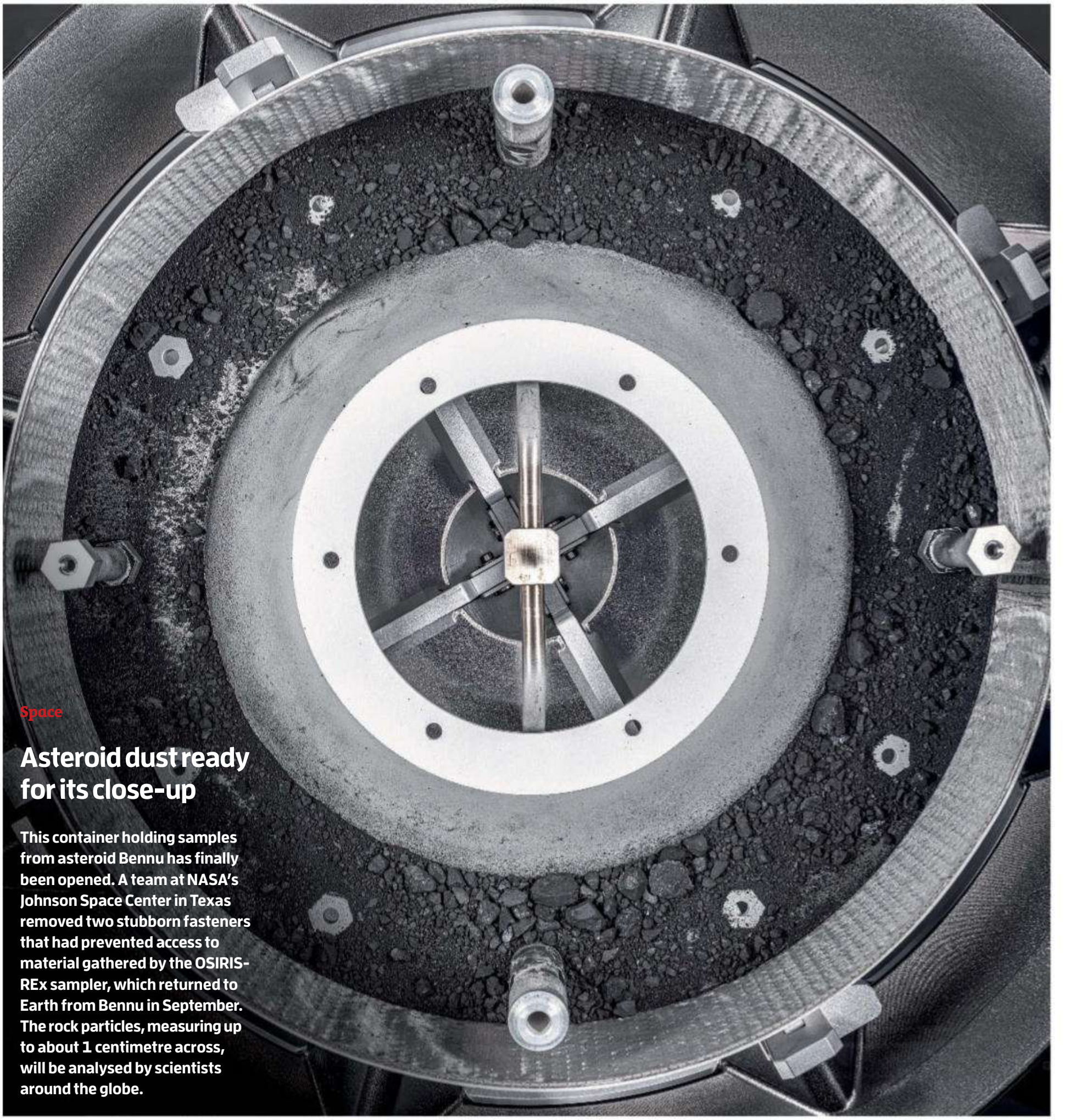


Space

Asteroid dust ready for its close-up

This container holding samples from asteroid Bennu has finally been opened. A team at NASA's Johnson Space Center in Texas removed two stubborn fasteners that had prevented access to material gathered by the OSIRIS-REx sampler, which returned to Earth from Bennu in September. The rock particles, measuring up to about 1 centimetre across, will be analysed by scientists around the globe.

NASA/ERIKA BLUMENFELD & JOSEPH AEBERS

Life

Ancient ecosystem revealed

Analysis of rocks in South Africa reveals a network of organisms thriving in the sea 3.4 billion years ago, adding to evidence for an even earlier origin of life, finds **Michael Marshall**

AS EARLY as 3.4 billion years ago, life on Earth had formed diverse communities. Exceptionally preserved remains from the period reveal an ecosystem of microorganisms that sustained themselves in a range of ways.

The complexity of the ecosystem suggests life had already existed for hundreds of millions of years and began early in Earth's history.

Manuel Reinhardt at the University of Göttingen in Germany and his colleagues studied rocks from the Buck Reef Chert, part of the Barberton Greenstone Belt in South Africa. The rocks are 3.42 billion years old and are thought to be the preserved remnants of shallow seas around a chain of volcanic islands.

DR. MANUEL REINHARDT

A sample of chert rock containing what may be the remains of microorganisms that lived 3.4 billion years ago

Carbon clues

The layers of rock contain microscopic blobs of carbon-based matter, believed to be the remains of microorganisms that lived in these waters. Reinhardt and his group analysed this material to determine its chemical makeup, which they used to infer what sort of metabolism these life forms had.

The team focused on the carbon itself. This element comes in several forms called isotopes,

4.1

Life might have emerged this many billion years ago

which are identical apart from the number of neutrons in the nucleus of the atom. The two main carbon isotopes are carbon-12 and carbon-13. Living things prefer to use carbon-12, so biological matter tends to have more carbon-12 and less carbon-13 than non-biological matter.

However, not all living things are equally good at preferentially absorbing carbon-12. That means the ratio between the two forms can provide clues about an organism's metabolism.

Much of the material studied has a carbon signature that matches photosynthesis: the ability to use light energy to make sugar. This suggests there were enormous quantities of photosynthetic microbes living near the surface of the sea billions of years ago (*Precambrian Research*, doi.org/mdcc).

However, some of the blobs had less carbon-12. Photosynthetic organisms can't achieve this, so Reinhardt says those microbes must have been feeding on a chemical called acetyl coenzyme A.

Other blobs had still lower levels of carbon-12, suggesting the microbes in them were making either methane or acetate as waste products, which other microbes were then feeding on.

It isn't possible to tell if all the microbes were living in exactly the same place at the same time, says Reinhardt. The photosynthetic ones must have lived near the surface of the water, but the others may have lived in sediments on the seabed.

The research is "brilliant" and "really painstaking", says Frances Westall at the French National Centre for Scientific Research in Orléans. "What I'm reading out of this is that early life was working very much similarly to life today."

The study also adds to the evidence for an early origin of life on Earth, earlier than a crude reading of the fossil record might suggest.

The oldest widely accepted evidence for life is 3.5 billion years old, from Pilbara in Australia. Researchers have reported evidence of older fossils from 3.7 billion years ago or even earlier, but others say the evidence isn't convincing in most of those cases.

"What I'm reading out of this is that early life was working very much similarly to life today"

"All the rocks older than about 3.5 billion years old, they are so badly metamorphosed," says Westall. That means the oldest ecosystems we can see are rich communities like the one Reinhardt's team studied. There must have been older and simpler versions, but we haven't seen them because they aren't preserved – at least not in ways we can currently detect. As a result, the earliest history of life remains unknown. "It's very difficult to see the trend, simply because of a lack of well-preserved rocks," says Westall.

What does seem clear is that life is significantly older than 3.5 billion years. "Personally, I think life emerged on Earth during the Hadean [eon], probably about 4.2, 4.1 billion years [ago]," says Westall. ▮

The Buck Reef Chert rock layer within the Barberton Greenstone Belt in South Africa was under the sea billions of years ago

INSTINCTIVELY RDH/SHUTTERSTOCK

Health

Endometriosis takes six years to be diagnosed due to a lack of awareness

Elizabeth Hlavinka

POOR access to healthcare and gaps in medical knowledge mean that endometriosis can take years, or even decades, to be diagnosed.

The condition occurs when tissue similar to the lining of the uterus grows in other places, such as the ovaries and fallopian tubes, which can lead to pain and difficulty conceiving. The cause of endometriosis is unknown, but it has been linked to genetics and immune system problems.

Researchers have previously reported how people with endometriosis often face a delay in diagnosis. To find out how widespread such delays are and why they occur, Jodie Fryer at North Yorkshire County Council in the UK and her colleagues at the University of York and York St John University looked at 22 studies from 18 countries.

They found that those with endometriosis wait an average of 6.6 years to be diagnosed, with much variation between countries. For instance, one study found that the diagnostic delay in Brazil is just six months, compared with 27 years in the UK. In the US, the average delay is 11 years, compared with 1.5 years in Australia, where the federal government announced a national action plan to improve endometriosis care in 2018.

The researchers found that poor access to private healthcare is a reason for delays in some countries for people with limited incomes. Some are also unable to physically access healthcare. The team also identified a general lack of endometriosis knowledge in medical professionals and people with the condition's symptoms.

Many of those with endometriosis say they feel unheard or as if their symptoms are dismissed. Five studies reported how people see an average of four doctors before they are diagnosed (medRxiv, doi.org/mdcb).

"Getting a diagnosis gives you the language to explain your experience and provides the gateway to access support and treatment," says Caroline Law at De Montfort University in Leicester, UK. Seeking a diagnosis on top of having symptoms can be really mentally gruelling, she says.

Linda Griffith at the Massachusetts Institute of Technology, who was diagnosed with endometriosis 14 years after the onset of her symptoms, cites how the condition used to be known as "the career woman's disease", as it was believed to affect those who delayed pregnancy to progress at work, despite sometimes arising in teenagers.

In 2022, endometriosis research received just 0.038 per cent of the US National Institutes of Health budget, despite the condition affecting at least 11 per cent of US women. The poor funding results in a lack of research, which then affects awareness and medical practice, says Elise Courtois at the Jackson Laboratory in Connecticut.

"It is extremely common and yet we don't know the most basic reason why endometriosis arises, how it spreads and how it evolves," she says. ▮

MENIGAULT BERNARD/ALAMY

People in Paris march to call for action on endometriosis in 2018

Space

Slim hope remains for resuscitating ailing moon lander

JAPAN'S stricken lunar craft could still be revived by sunlight. Its Smart Lander for Investigating Moon (SLIM) touched down on the surface on 19 January, making the country the fifth to manage this, after the US, the Soviet Union, China and India.

But the probe's solar panels were pointing west, away from the sun, leaving it operating on batteries. These were turned off 3 hours after touchdown to save power, putting the craft to sleep.

The Japan Aerospace Exploration Agency (JAXA) launched SLIM in September 2023 and it took a long, looping path to its final destination, circling Earth several times in order to save fuel. Since December, it has been orbiting the moon, taking images of the surface and preparing for landing.

Its touchdown marked the first use of a technology that engineers have nicknamed "smart eyes", which allowed SLIM to target its landing spot with extreme precision. This system compared images from its on-board cameras to data from other spacecraft orbiting the moon to pinpoint its own location, and then autonomously navigated to its landing spot on the slope of Shioli crater.

Unless SLIM can be restarted, the mission's scientific capabilities are drastically reduced. Although it is in sleep mode at the moment, SLIM dropped off two tiny rovers, each with its own small payload of scientific instruments, as it flew down to the lunar surface. One of them is designed to hop around instead of rolling on wheels, while the other is a sphere slightly smaller than a tennis ball, designed by a toy manufacturer to roll across the lunar surface. The rovers seem to be functioning properly.

"If sunlight hits the moon from the west, we believe there's a possibility of power generation"

JAXA hopes the lander can be awoken, though. "If sunlight hits the moon from the west in the future, we believe there's a possibility of power generation, and we're currently preparing for restoration," the agency said in a statement. ▮

Leah Crane

Technology

First ‘thermodynamic computer’

A prototype computer harnesses random physical fluctuations – or noise – to run calculations

Karmela Padavic-Callaghan

A COMPUTER can now perform calculations using just the random “noise” that is inherent in our world. It is built using standard components and could eventually run artificial intelligence programs more efficiently than conventional computers.

In conventional computers, all calculations are reduced to sequences of 1s and 0s. However, these computers must contend with random thermodynamic noise, like a piece of a circuit warming up and unexpectedly turning a 0 into a 1. This causes errors, but Patrick Coles at New York-based start-up Normal Computing and his colleagues have built a computer that takes advantage of the noise instead.

“We are making lemonade out of lemons, using the fact that physical systems are naturally noisy,” says Coles.

The researchers built a prototype thermodynamic computer – which they named the stochastic processing unit or SPU – on a circuit board similar to those used in conventional computers. It contains eight interconnected circuits, each of which stores energy in an electric oscillation – a little like an electric version of a swinging pendulum.

NORMAL COMPUTING

The circuit board of the SPU “thermodynamic computer”

A thermodynamic computer receives its inputs from the physical environment rather than through a keyboard. For instance, if one of its components gets warmer, the computer takes advantage of that process to perform a calculation. Because the warm component would change temperature in any case, exploiting this to perform a calculation makes the computer more efficient.

To use the SPU, the Normal Computing researchers exposed it to electrical currents with random, small-amplitude fluctuations. They ran different computations by changing these input currents, tuning the circuits so that, for instance, one “pendulum” has a greater influence over the way the other seven oscillate. They then measured the currents and voltages of the SPU’s circuits to assess the result of the calculation.

The researchers successfully ran a program that can find the inverse of a so-called mathematical matrix, which can be a challenging calculation. They also ran several programs that are important for creating and using generative AI algorithms (arXiv, doi.org/mdb8).

“I think it’s not widely appreciated what could be done with thermodynamic computing, and this is a good start,” says Todd Hylton at the University of California, San Diego.

“The fundamental proposition behind thermodynamic computing is that, essentially, if we were less prescriptive in telling the hardware what to do, and let it sort of do these thermodynamics

“We are making lemonade out of lemons, using the fact that physical systems are naturally noisy”

[processes] that are already there more naturally... then we would get much more capable AI systems and probably ones that are much more energy efficient,” he says.

Artemy Kolchinsky at Pompeu Fabra University in Spain says that if the SPU were made bigger, it might be useful for computations beyond AI. ▮

Environment

Seaweed could help avert global famine after a nuclear war

ONE of the best options for feeding people in the event of a nuclear catastrophe that blots out the sun may be seaweed.

If nuclear war broke out, burning cities and forests could emit 150 million tonnes of soot, dimming the sun. Temperatures could drop by 9°C (16°F) and global food production from agriculture could decline 90 per cent in the first year of nuclear winter. An asteroid impact could similarly disrupt our food systems by occluding sunlight.

Florian Ulrich Jehn at the Alliance to Feed the Earth in Disasters and his colleagues have modelled how well seaweed would fare under the nuclear scenario. They found that seaweed would still be able to grow up to 13 per cent per day in places such as the east Pacific.

Within nine to 14 months, seaweed cultivated on ropes between buoys could supply up to 15 per cent of the food currently eaten by humans, as well as 10 per cent of animal feed and 50 per cent of biofuel production, according to the simulation. Expanded seaweed cultivation could avert up to 1.2 billion deaths from starvation, the team estimates (*Earth’s Future*, doi.org/mdf9).

“We will need food, and we will need a lot of it because our current food system won’t work any more,”

PAUL FELIX PHOTOGRAPHY/ALAMY

Seaweed being harvested in Cornwall, UK, for sale to restaurants

says Jehn. “[Seaweed] is definitely one of the top candidates.”

The tropics and some of the subtropics would still have enough warmth and light to grow some land crops as well as seaweed, which is typically limited by nutrient availability. In a nuclear winter, cooling surface waters would sink and force nutrient-rich deep waters to rise. That would expand the area suitable for growing seaweed like *Gracilaria tikvahiae*, a red alga that is already farmed for food in Asia.

A 2023 United Nations report found that farmed seaweed is a low-carbon source of protein and other nutrients that could boost food security. But it can absorb dangerous levels of heavy metals in polluted waters. ▮

Alec Luhn

Health

Life expectancy gap between men and women is closing

Chen Ly

WOMEN have historically outlived men, but changing lifestyles may be helping men to catch up.

Globally, the average human lifespan has risen over the past century, a trend that is expected to continue as nations become richer. But there has been a consistent gap between the life expectancies of men and women.

Now, David Atance del Olmo at the University of Alcalá in Spain and his colleagues have analysed the mortality data of 194 countries from 1990 to 2010.

They divided the countries into five groups according to their longevity trends. The group with the highest life expectancies included the places with the highest incomes, such as Australia, Japan, the US, the UK and other parts of western Europe. The group with the lowest life expectancies consisted of just Rwanda and Uganda.

The greatest life expectancy jump was among men in Rwanda and Uganda, who had an average life expectancy of just 30.85 years in 1990, increasing by 14.37 years to 45.22 years in 2010. Among women in these countries, life expectancy increased over this period by just 0.94 years, from 50.37 years to 51.31 years.

In the group with the highest life expectancies, the average gap between men and women in 1990 was 4.84 years, tipping in women's favour. This dropped to 4.77 years in 2010, and the researchers think the gap will have continued to close (*PLoS One*, doi.org/gtd2pq).

In recent decades, both men and women have benefited from advances in healthcare, says del Olmo. Smoking and alcohol-related deaths, which disproportionately affect men, have also decreased, which may have helped to reduce the life expectancy gap, he says. ▮

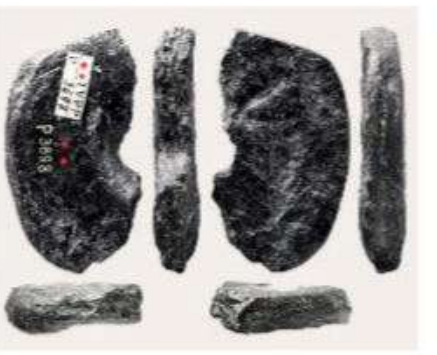
See page 13 for more on lifespan

Archaeology

Humans reached China thousands of years earlier than we thought

Michael Marshall

L: ESTEBAN DE ARMAS/ALAMY; R: F. D'ERRICO ET AL. (2023)



Left: the first modern human to reach China may have come from the north. Above: artefacts including a graphite disc from the Shiyu site, China

MODERN humans were living in what is now China by 45,000 years ago. The finding means our species reached the area thousands of years earlier than was generally thought.

Francesco d'Errico at the University of Bordeaux in France and his colleagues have re-examined an archaeological site called Shiyu in northern China. It was first excavated in 1963, not long before the unrest of China's Cultural Revolution. "This was not the best moment to find such an important site," says d'Errico.

Shiyu is an open-air site in a river gully. It holds a 30-metre-deep deposit of sand and other sediment, which the original excavators divided into four layers, the second-from-bottom of which was found to hold evidence of human occupation.

The excavators found more than 15,000 stone artefacts and thousands of animal bones. There was also a piece of hominin skull, identified as modern human (*Homo sapiens*).

Some artefacts were taken to Beijing's Institute of Vertebrate Paleontology and Paleoanthropology. But those left at local facilities – including the hominin bone – were lost. "We have perhaps 10 per cent of the stone tools," says d'Errico.

D'Errico and his colleagues have re-excavated Shiyu to find its age. They dated 15 sediment samples using a technique called optically stimulated luminescence and carbon-dated 10 animal bones and teeth. They say the hominin layer is about 44,600 years old (*Nature Ecology & Evolution*, doi.org/mdb6).

The Shiyu hominins were probably *H. sapiens*, says Arina Khatsenovich at the Institute of Archaeology and Ethnography in Novosibirsk, Russia, who wasn't involved in the study.

5000

Number of years the arrival of modern humans in China has been pushed back

As such, the new study implies modern humans had reached northern China about 45,000 years ago. This pushes back our species' arrival in China by about 5000 years. The next oldest *H. sapiens* site in China is Tianyuan cave, which is 40,000 years old, says d'Errico.

Some researchers have claimed our species arrived earlier, potentially up to 260,000 years ago. But d'Errico says others have critiqued much of the evidence for such an early presence in the region.

It may be that, as humans entered Asia from Africa, they spread out via multiple routes, says Khatsenovich. As well as exploring the tropical southern regions of Asia, they also seem to have gone further north. Khatsenovich says there are signs of a modern human presence in this region, including at Obi-Rakhmat grotto in Uzbekistan from 48,800 years ago. It may be that our species reached Shiyu, and China, via this northern route.

As modern humans arrived, they encountered hominins that already lived there, like the Neanderthals and, further east, the Denisovans. There may have been cultural exchanges: the artefacts at Shiyu include some that look more like tools from these earlier groups and four pieces of obsidian, a volcanic glass. The team traced them to sites 800 and 1000 kilometres north-east of Shiyu. D'Errico says it is unlikely the inhabitants travelled this far themselves. ▮

Analysis Technology

What does Ukraine's million-drone army mean for the future of war?

In 2024, the besieged nation is likely to have more drones than soldiers in its armed forces. It is changing the way war is waged, finds **David Hambling**

UKRAINE'S president Volodymyr Zelensky has promised that in 2024 the country's armed forces will have a million drones. His nation has already deployed hundreds of thousands of mainly smaller drones, but this is a big shift – a transition to a military with more of these machines than soldiers. What does that mean for the future of armed conflict?

Such technology has already transformed the conflict between Russia and Ukraine. "At this point in Ukraine, anything that moves – a soldier or a vehicle – can be identified, tracked and ultimately hit with a drone," says Samuel Bendett, adviser to the Center for a New American Security think tank. "This is a major change from previous conflicts even a few years ago."

UKRINFORM/SHUTTERSTOCK

A batch of DJI Matrice 300 RTK drones, part of Ukraine's "Army of Drones" project

Small drones, many of them quadcopters that are available to consumers, have played a key role. From not long after Russia invaded in February 2022, Ukraine has used such models as scouts, to direct artillery fire and to drop small grenades. They are often known as Maviks after the Mavic drone made by Chinese firm DJI. Russian soldiers soon copied these tactics.

> **"Before the war, the common thinking was Ukraine would get demolished"**

These consumer machines have been supplemented with smaller numbers of heavy multicopters to drop bombs and longer-range reconnaissance types resembling tiny aircraft, as well as single-use attack drones that are essentially diminutive cruise missiles. Ukraine now fields assault units made up of a mix of different sorts of drones.

"Before the war, the common thinking was Ukraine would get demolished," says Zachary Kallenborn at the Center for Strategic and International Studies, a US think tank. That didn't happen. "Although a range of causes, from international support to Ukrainian courage, helped them mount a historic defence, drones no doubt were a big factor."

The use of this technology in the war accelerated in late 2022, with the introduction of first-person view (FPV) racing quadcopters repurposed as guided weapons. Their powerful motors mean they can carry an anti-tank warhead 20 kilometres to destroy tanks, artillery and other targets. FPVs can chase down speeding trucks, enter buildings and bunkers through windows and doorways or dive into trenches, and have been built in large numbers.

Commanders on both sides were initially sceptical about using consumer drones on the battlefield, and procurement has largely been via volunteer groups, donors or soldiers buying the devices themselves. But governments are now driving the efforts.

"This war has demonstrated an unprecedented use of commercial drone technology by state militaries," says Bendett.

Ukraine deployed an estimated 200,000 of them in 2023, mainly FPVs and Mavik types, something made possible by the low-cost, off-the-shelf nature of the machines, in contrast to the usual slower military procurement process.

"Over 50 per cent of equipment and personnel are destroyed by drones, and the other 50 per cent are destroyed with assistance from drones," according to one volunteer quoted by United24, a fundraising initiative set up by Zelensky that has helped buy the devices.

War of adaptation

It was also initially thought that drones would be very vulnerable to radio-frequency jamming, which blocks communication between them and the operator. But while thousands of drones have succumbed to such electronic attacks, operators modify them with anti-jamming measures such as filters and receivers working on different frequencies.

"Jamming and other countermeasures do have an effect on drones, but there is an adaptation-counter-adaptation race taking place in Ukraine, with new counter methods and technologies appearing constantly," says Bendett.

One response to jamming is to make drones more autonomous so they can navigate and carry out attacks without continuous control. The operator just indicates a target and the drone does the rest. Kallenborn says these systems, often using artificial intelligence, are currently quite brittle and prone to failure. "I expect both sides to experiment with and field autonomous systems, but still probably at a more limited scale or for more narrow functions," he says.

Kallenborn and Bendett both say this war is likely to set the pattern for future conflicts. A key factor in the rise of the drones has been the fast speed with which new ones can be deployed and how $400 FPVs can be fielded in much larger numbers than $200,000 Javelin anti-tank missiles.

"We can absolutely expect to see extensive drone use in future conflicts," says Kallenborn.

"The war has demonstrated that a military that wants to field many drones need not spend a lot on their development, procurement and use," says Bendett. "We are seeing this pattern already in the Israel-Hamas war, Sudan civil war, Syria civil war and the use of drones by drug cartels in Latin America."

The US Department of Defense is also attempting to capitalise on Ukraine's success with a project called Replicator, which would allow it to rapidly field thousands of small, highly capable drones.

Although the use of drones is becoming frequent in many conflicts, the ways they are put to work can be very different, says Kallenborn. "I suspect the debate will shift to what specific types of drones are useful in which roles, in what quantities." ▮

Animal disease

Mass death of elephant seal pups raises fears of bird flu spreading in mammals

Luke Taylor

AN UNPRECEDENTED mass die-off of elephant seals on the shores of Patagonia, Argentina, suggests that a highly contagious strain of bird flu is now being transmitted between mammals and poses a growing threat to the world's biodiversity, say researchers.

Some 96 per cent of elephant seal pups (*Mirounga leonina*) at three breeding sites where the H5N1 strain of avian flu was detected in the Valdes Peninsula region in southern Argentina died in October 2023, say Claudio Campagna at the Wildlife Conservation Society and his colleagues.

Extrapolating the mortality rate at the three sites, the researchers estimate that 17,400 baby elephant seals were killed by the virus in Patagonia, the highest figure since scientists began studying their numbers closely three decades ago (*Marine Mammal Science*, doi.org/mdbw).

"The mortality of pups was extraordinary, catastrophic and probably also included a large number of adults," says Campagna. "It may take decades for these seal populations to get back to where they were."

H5N1 was first detected in China in 1996 and had been largely confined to domesticated birds.

96%

Proportion of elephant seal pups that have died at three sites

But since 2021, it has spread more quickly in wild populations in the Americas and Europe.

The virus has infected at least 320 bird and 25 mammal species. More than 500,000 birds in South America – the most affected region – have died from the flu strain and a growing number of mammal species are being affected. A polar bear in Alaska was killed by the virus earlier this month.

Researchers largely thought mammals were only catching the virus from contact with infected birds, such as by eating them or eating farm feed contaminated with infected bird faeces. However, there is growing evidence that H5N1 may now be spreading from mammal to mammal.

Some studies suggested last year that H5N1 may be circulating between farmed mink in Spain and between wild seals in the US.

At the sites where elephant seals were found dead, they had little to no interaction with infected bird populations, says Campagna. It is also highly unlikely that such a large number of mammals could have been infected in less than a month without the infection being transmitted among them. "We now have to conclude that this was mammal-to-mammal transmission," he says.

Newborn elephant seal pups suckle their mothers to feed, so there is little chance of eating infected birds, says team member Marcela Uhart at the University of California, Davis.

The disease also spread rapidly in sea lions all along the Atlantic coast in August last year, killing thousands in areas where few birds were affected, suggesting the sea lions could transmit the virus, says Uhart. "This is all highly suggestive of some sort of transmission between mammals."

Mammal-to-mammal transmission increases the risk to the world's mammals and also the chance of the virus eventually adapting to infect humans more easily, says Uhart. We must quickly study H5N1 in other affected populations to understand its genetic mutations in mammals and the possible risk to humans, she says. ▮

Health

Mild haemophilia may add an extra year or two to life

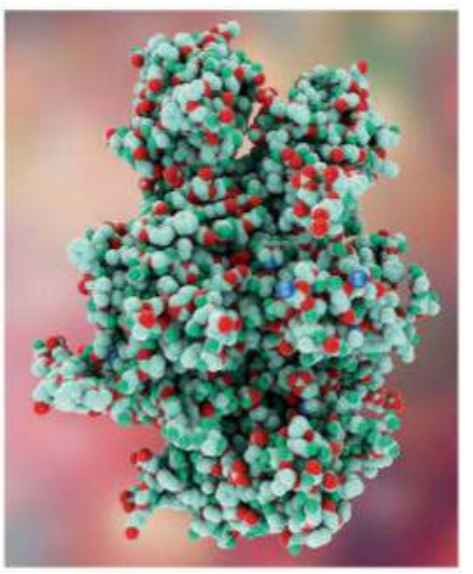
PEOPLE with mild haemophilia, which reduces blood clotting, seem to have a longer life expectancy than those without it. This may be because they are less likely to have strokes and heart attacks, which can be caused by clots.

The finding comes from the latest figures on outcomes for people with haemophilia in the UK, which suggest that those with milder forms have an average life expectancy of 84 years. This is 1.7 years more than for UK men as a whole, according to the Office for National Statistics. About 9 in 10 people with the condition are men.

Haemophilia is heritable, caused by mutations in a gene that encodes one of the proteins involved in making blood clot after an injury. The most common form involves mutations in the gene that encodes a protein called factor VIII.

Depending on the mutation, people can have varying levels of factor VIII in their blood. Having 5 to 40 per cent of the typical factor VIII level is classed as mild haemophilia and those with this don't usually bleed spontaneously.

People with any form of haemophilia used to have a lower life expectancy than average. It has risen over recent decades, according to a November report from the UK Haemophilia Centres Doctors' Organisation (UKHCDO). This is due to several factors, including health systems getting better at identifying the condition and giving the right treatments, says Michael Makris at the University of Sheffield, UK.



UKRINFORM/SHUTTERSTOCK

An illustration of the factor VIII protein, which helps blood to clot

For those with the mild form, the above-average life expectancy now seen in the UK may be a sign of possible advantages of blood that is less likely to form potentially dangerous clots, says Makris. Supporting this idea, in 2022 Makris and his team showed that people with haemophilia are about a third as likely to have cardiovascular conditions as other individuals.

Susie Shapiro at the UKHCDO finds the idea interesting, but says the differences could be a statistical fluke. "I'd be cautious about the strength of the conclusion about greater life expectancy because the number of older people with mild haemophilia is small," she says. ▮

Clare Wilson

Environment

Seabed trawling is a major source of global CO_2 emissions

Michael Le Page

FISHING by bottom trawling releases about 340 million tonnes of carbon dioxide into the atmosphere each year, according to the first study to estimate these emissions. That is nearly 1 per cent of global CO_2 emissions, a major contribution that has been overlooked until now.

Trawling involves dragging weighted nets across the seafloor to catch bottom-dwelling fish, crustaceans and shellfish. The practice is widely used, but the fishing gear damages seafloor environments such as coral reefs.

"Bottom trawling is an extremely destructive form of fishing as the nets and weights dragged along the bottom destroy marine habitats that can take many years to re-establish and recover," says Mika Peck at the University of Sussex, UK, who wasn't involved in the research.

It also stirs up sediments, providing the oxygen that microbes need to break down organic matter into carbon dioxide. Those sediments might otherwise continue to build up for many millennia, preserved by low-oxygen conditions, so the carbon is locked away.

In 2021, Trisha Atwood at Utah State University in Logan and her colleagues combined studies looking at how much CO_2 may be released during trawling with data on the extent of trawling worldwide from an organisation called Global Fishing Watch.

The team concluded that massive amounts were released into the seawater. But the big unanswered question was how much of the CO_2 released from sediments ends up in the atmosphere.

NARISAFOTOSS/SHUTTERSTOCK

In bottom trawling, weighted nets are dragged across the seafloor

So the team has combined forces with researchers who have developed computer models of ocean circulation. According to those models, some 55 per cent of the CO_2 released into water by trawling will end up in the atmosphere after nine years (*Frontiers in Marine Science*, doi.org/gtd28c).

"I was surprised that about more than half comes out," says Atwood. "And that it comes out quite rapidly."

340

Annual CO_2 emissions of bottom trawling in millions of tonnes

According to a report by the Global Carbon Project, total CO_2 emissions from human activities rose to 40.9 gigatonnes in 2023. So if the team's estimate is correct, trawling accounts for around 0.8 per cent of global emissions, compared with 2.8 per cent for aviation and shipping.

Conservationists say the findings strengthen the case for reducing trawling. "A ban of destructive fishing practices is key to the future of healthy marine ecosystems," says Peck.

"Measures to reduce the carbon impact of bottom-towed fishing gear are urgently needed, though it must be done as part of a 'just transition'," says Gareth Cunningham at the Marine Conservation Society. "There isn't a one-size-fits-all model, and solutions will vary from one location to another."

Not all researchers are convinced by the numbers. "I'm very sceptical about their estimates," says Jan Geert Hiddink at Bangor University, UK. He thinks much of the carbon that reaches the seafloor is in hard-to-break-down forms, such as in bones, so isn't released even when sediments are disturbed. Atwood's team may be overestimating the quantity released by up to 1000 times, he argues.

Atwood says the estimate is based on measurements. "We took studies that measure the amount of CO_2 that was coming off of the seabed in areas that are trawled," she says. ▮

Health

Beeping shoes boost walking ability in Parkinson's disease

Sara Novak

SHOES that beep when someone walks with a strong stride can improve stability in people with Parkinson's disease.

Parkinson's occurs due to a loss of nerve cells in part of the brain called the substantia nigra. This leads to a reduction in a chemical called dopamine, which helps regulate movement. As a result, symptoms can include tremors and balance problems.

In an effort to overcome this, researchers at Physio Biometrics in Montreal, Canada, have created a sensor called Heel2Toe that clips onto the inside of shoes. When a user walks with a strong heel-to-toe motion, it sends a signal via Bluetooth to a smartphone, which produces a beeping sound.

To test the sensor, Nancy Mayo, who works at Physio Biometrics and McGill University in Montreal, and her colleagues worked with 21 people with Parkinson's who had gait issues but could walk without a stick. All participants had five sessions with a physiotherapist and were given a workbook with tips for stable walking. Fourteen of them were also given the Heel2Toe sensor, which they were told to wear while walking for at least 5 minutes, twice a day.

Three months later, 13 of the 14 people who wore the sensor walked further in a 6-minute test than they did at the start of the study. There was no improvement for the other people (medRxiv, doi.org/mc48).

"The brain loves getting rewards, and this device provides a congratulatory beep every time you make a good step," says Mayo.

The researchers didn't test if the sensor changes dopamine levels in the brain, but Mayo says it might stimulate "a dopamine-driven reward and feedback loop" that helps compensate for the reduction in the chemical among people with Parkinson's. ▮

Physics

‘Quantum vortex’ mimics black holes

Researchers have made a surprisingly large quantum vortex in a tank of superfluid helium

Leah Crane

A GIANT quantum vortex may allow researchers to study black holes. It comprises an eddy in a special form of liquid helium that displays quantum effects. The result has some properties similar to black holes, allowing it to act as a sort of simulator.

In the areas around black holes, the rules of gravity and quantum mechanics interact, leading to effects that aren’t observable anywhere else in the cosmos. This makes those regions particularly important to study.

“There’s all this interesting physics that occurs around black holes, but so much of it is out of reach,” says Silke Weinfurtner at the University of Nottingham, UK. “We can use these quantum simulators to investigate the phenomena that happen around black holes.”

To build their quantum simulator, Weinfurtner and her colleagues used superfluid helium, which flows with extraordinarily low viscosity – 500 times lower than that of water. Because it moves without friction, this form of helium exhibits unusual quantum effects, and it is known as a quantum fluid. The researchers placed the helium in a tank with a spinning propeller at the bottom. As the propeller rotated, it created a tornado-like vortex in the fluid.

“While similar vortices have been made before in physical systems other than superfluid helium, their strength is typically at least a couple of orders of magnitude weaker,” says team member Patrik Švančara, also at the University of Nottingham. The strength and size of the vortex are crucial for generating interactions between it and the rest of the fluid in the tank that are significant enough to observe.

We might be able to study black holes by making vortices in helium

The vortex in this work measured several millimetres across, much larger than other stable ones that have been created in quantum fluids in the past.

Creating such a large version is difficult because in quantum liquids, rotation can only occur in tiny “packets” called quanta, which are essentially small vortices. When many of them are clustered together, they tend to become unstable, but the experimental set-up here allowed the researchers to combine about 40,000 quanta of rotation together to form what they call a giant quantum vortex (arXiv, doi.org/mdbm).

“It’s an experimental tour de force,” says Jeff Steinhauer at the Technion-Israel Institute of Technology.

The researchers observed how tiny waves in the fluid interacted with the vortex, a process that mimics the way that cosmic fields in space interact with rotating black holes. They found hints of a black hole phenomenon called a ringdown mode, which occurs after two black holes combine and the resulting one jiggles due to the residual energy from the merger.

“This offers an excellent starting point to investigate several black hole physics processes, with the potential of seeking new insights and uncovering hidden treasures along the way,” says Weinfurtner. ▮

SHUTTERSTOCK/TYOMOCHKA

Life

Megalodon was nothing like a giant great white shark

THE ancient shark megalodon, often depicted as a super-sized great white, was probably a longer, more slender beast, according to a new fossil analysis.

Best known from its depiction in the *Meg* film franchise, *Otodus megalodon* went extinct some 3.5 million years ago. It was one of the largest marine predators to have lived, but no complete skeleton has been found.

A 2022 study by Jack Cooper at Swansea University, UK, and his colleagues reconstructed the animal based on a partial fossilised skeleton known as IRSNB P 9893. The results showed a stocky, powerful shark built for bursts of speed to attack prey, similar to a great white shark (*Carcharodon carcharias*) – but, at 15.9 metres, about three times as long.

Charles Underwood at Birkbeck, University of London, says that study made “tenuous assumptions” about the size of megalodon based largely on it having similar teeth to a great white, although megalodon’s are much larger. He is part of a group of 26 shark experts that aims to set the record straight.

According to Underwood, Cooper’s team didn’t realise how incomplete the skeleton was and how many vertebrae it was missing.

The team behind the new study says the strength of the spinal column suggests a more slender body shape. “It would almost certainly not be feeding like modern great whites,” says Underwood. Its slimmer form means it wouldn’t have had huge acceleration, so it would have pursued rather than ambushed prey (*Palaeontologia Electronica*, doi.org/gtfdrx).

“No matter which hypothesis you support about its body shape, it was a very big shark”

Based on another partial fossil, the biggest specimen of megalodon was estimated to be 20 metres long. Underwood thinks it might actually have been 24 metres long.

Cooper stands by his stockier megalodon. “No matter which hypothesis you support about its body shape, it was a very big shark,” he says. ▮

Matthew Sparkes

Artificial intelligence

AI cracks hard maths

An AI from Google DeepMind scores almost as well as the best students on geometry questions from the International Mathematical Olympiad, finds **Alex Wilkins**

AN ARTIFICIAL intelligence from Google DeepMind can solve some International Mathematical Olympiad (IMO) questions on geometry almost as well as the best human contestants.

"The results of AlphaGeometry are stunning and breathtaking," says Gregor Dolinar, the IMO president. "It seems that AI will win the IMO gold medal much sooner than was thought."

The IMO, aimed at secondary school students, is one of the world's most difficult maths competitions. Answering questions correctly requires mathematical creativity, which AI systems struggle with. GPT-4, for instance, which has remarkable reasoning ability in other domains, scores 0 per cent on IMO geometry questions, and even specialised AIs struggle to answer as well as average contestants.

This is partly down to the difficulty of the problems, but also because there are few problems to train on. The competition has been run annually since 1959, and each edition consists of just six questions. Some of the most successful AI systems, however, require billions of data points to learn what to do. Geometrical problems, which make up one or two of the six questions and involve proving facts about angles or lines in complicated shapes, are particularly difficult to translate to a computer-friendly format.

GOOGLE DEEPMIND

Geometry problems involve proving facts about angles or lines in complicated shapes

Gold standard

Thang Luong at Google DeepMind and his colleagues have bypassed this issue by creating a tool that can generate hundreds of millions of machine-readable geometrical proofs. When they trained their AlphaGeometry AI using this data and tested it on 30 IMO geometry questions, it answered 25 correctly, compared with an estimated score of 25.9 for an IMO gold medallist based on their scores in the contest (*Nature*, doi.org/mczz).

"Our [current] AI systems are still struggling with the ability to do things like deep reasoning, where we need to plan ahead for many, many steps and also see the big picture, which is why mathematics is such an important benchmark and test set for us on our quest to artificial general intelligence," Luong told a press conference.

AlphaGeometry consists of two parts, which Luong compares to different thinking systems in the brain: a fast, intuitive system and a slower, more analytical one. The first, intuitive part is a language model, similar to the technology behind ChatGPT, called GPT-f. It has been trained on the millions of generated proofs and suggests which theorems and arguments to try next for a problem. Once it suggests a next step, a slower and more careful "symbolic reasoning" engine uses logical and mathematical rules to fully construct the argument that GPT-f has suggested. The two systems then work in tandem, switching between one another until a problem has been solved.

While this method works on IMO geometry problems, the answers it constructs tend to be longer and less "beautiful" than human proofs, says Luong. But it can spot things that humans miss. For example, it discovered a better and more general solution to a question from the 2004 IMO than was listed in the official answers.

"It seems that AI will win the IMO gold medal much sooner than was thought"

Solving IMO geometry problems in this way is impressive, says Yang-Hui He at the London Institute for Mathematical Sciences, but the system is inherently limited in the mathematics it can use because IMO problems should be solvable using theorems taught below undergraduate level. Expanding the amount of mathematical knowledge AlphaGeometry has access to might improve the system or even help it make new mathematical discoveries, he says.

On the money

It would also be interesting to see how AlphaGeometry copes with not knowing what it needs to prove, as mathematical insight can often come from exploring theorems with no set proof, says He. "If you don't know what your endpoint is, can you find within the set of all [mathematical] paths whether there is a theorem that is actually interesting and new?"

Last year, algorithmic trading company XTX Markets announced a $10 million prize fund for AI maths models, with a $5 million grand prize for the first publicly shared AI model that can win an IMO gold medal, as well as smaller progress prizes for key milestones.

"Solving an IMO geometry problem is one of the planned progress prizes," says Alex Gerko at XTX Markets. "It's exciting to see progress towards this goal, even before we have announced all the details of this progress prize, which would include... solving an actual geometry problem during a live IMO contest."

Google DeepMind declined to say whether it plans to enter AlphaGeometry in a live IMO contest or whether it is expanding the system to solve other IMO problems. However, the company has previously entered public competitions for protein-folding prediction to test its AlphaFold AI system. ▮

Environment

Fertilisers add microplastics into agricultural soil

Bárbara Pinho

A MAJOR source of microplastic pollution in agricultural soil is fertilisers, according to a long-running experiment in the UK, and this pollution has increased dramatically in the past 50 years.

WAYNE HUTCHINSON/ALAMY

Fertilising slurry sprayed on fields can hold microplastics

Samuel Cusworth at Lancaster University, UK, and his colleagues looked at soil samples collected at agricultural science centre Rothamsted Research in an experiment that has been running since 1843. The samples came from three groups: soil that had received no fertiliser, soil treated with organic fertilisers such as manure or organic compost and soil treated with conventional fertilisers.

Samples collected before 1966 contained little or no trace of microplastics. In the samples from the past 50 years, there was a significant increase in microplastic concentrations in all three groups. However, soils treated with either organic or inorganic fertilisers contained more microplastics, showing that fertilisers are a major contributor (*Communications Earth & Environment*, doi.org/mcz3).

"With organic fertilisers, if any of the feed that's been given to the farmyard animals contains any plastic, this will be digested and end up in faeces," says Cusworth.

Inorganic fertilisers can spread microplastics because many of them are coated with polymers to ensure that nutrients are released slowly, he adds. ▮

Health

Kimchi and cheeses can contain antibiotic-resistant bacteria

James Woodford

FERMENTED food such as kimchi and certain cheeses can host antibiotic-resistant bacteria, some of which have the potential to cause ill health.

Hua Wang at The Ohio State University in Columbus and her colleagues assessed 10 types of kimchi – a traditional Korean dish made with salted and fermented vegetables – and four artisan cheeses, bought from either local or national retail stores, or Japanese or Korean restaurants, in the Columbus area.

The team found that nine of the kimchi products and all of the cheeses contained antibiotic-resistant bacteria, some of which have the potential to cause gut-related symptoms or more severe health issues if they enter the bloodstream. They also contained lactic acid bacteria, which drive fermentation, that were similarly resistant to some antibiotics.

Although fermentation bacteria can acquire or develop resistance to antibiotics, that would only be a problem if they caused an infection or transferred their antibiotic-resistance gene to another bacterium, which "is possible but hasn't yet been shown", says Mark Turner at the University of Queensland in Australia.

But one of the retail-bought kimchi products the researchers tested contained a strain of *Weissella*, a type of fermentation bacterium that was found to be highly resistant to antibiotics (bioRxiv, doi.org/mcz2).

"If these strains get into the bloodstream through gastrointestinal tract issues, they can cause bacteraemia [a bloodstream infection] or sepsis, untreatable by antibiotics," says Wang. "This is regardless of the transfer of antibiotic resistance genes in the gut."

In another part of the experiment, the team made some kimchi samples. "These also invariably contained antibiotic-resistant strains of microbes," says Wang. Such bacteria may be on the raw vegetables or in the water used to make the dish, with fermentation accelerating their growth, she says.

The mainstream dairy industry often uses pasteurised milk, along with starter cultures – bacteria grown to kick-start the transformation of milk into cheese – that have been screened for antibiotic-resistant pathogens, say the researchers. Artisan manufacturers may use unpasteurised milk and cultures that haven't been screened, though.

Finally, the team reassessed genetic data from a previously published study. Out of 36 adults, half were told to eat a diet high in plant-based food, while the other half ate a diet rich in fermented food.

After 10 weeks, those who ate more fermented food had a greater abundance of genes associated with antibiotic-resistant bacteria in their stools. There was no change among those in the other group.

People with issues affecting their digestive tracts or immune systems could become ill after ingesting these microbes, says Wang.

Many people also turn to fermented food after a course of antibiotics or an illness,

"If these strains get into the bloodstream, they can cause untreatable bacteraemia or sepsis"

in an effort to reset their gut health. These individuals may be most at risk when consuming fermented food with antibiotic-resistant bacteria, says Wang.

Furthermore, ingesting such microbes could worsen the antibiotic resistance crisis when they enter the environment via faeces.

Wang expects similar results to apply to other homemade or artisan fermented food and drinks, such as sauerkraut, made with raw cabbage, and kombucha, black tea made with a symbiotic culture of bacteria and yeast, or SCOBY.

Wang urges people to be cautious if they are making fermented food and to opt for screened starter cultures and pasteurised milk.

"Antibiotic resistance is a major issue that humankind is facing, especially bacteria that have developed resistance to last-line antibiotics," says Turner. ▮

Kimchi is a Korean dish made with salted and fermented vegetables

STOCKFOOD/WISCHNEWSKI, JAN

Life

How tardigrades survive extremes

MOLECULAR sensors help tardigrades withstand extreme environments. In freezing temperatures or intense radiation, these microscopic, eight-legged invertebrates shrivel up into a dry ball called a tun and enter a state of deep hibernation.

To investigate how the animals do this, Derrick Kolling at Marshall University in West Virginia and his colleagues exposed tardigrades to high levels of hydrogen peroxide, sugar or salt, or to -80°C (-112°F) to induce tuns. Under these stresses, the tardigrades produce reactive molecules called oxygen free radicals. These oxidise an amino acid called cysteine, signalling the onset of the dormant state. When conditions improved, cysteine was no longer oxidised and the tardigrades woke (*PLoS One*, doi.org/mc4n). **Chen Ly**

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Technology

Reddit can predict crypto price changes

CRYPTOCURRENCY traders could have tripled their money by basing their investments on whether the number of posts mentioning a currency on Reddit was greater than the day before.

Emiliano De Cristofaro at the University of California, Riverside, and his colleagues analysed around 130 million posts on 122 forums, or subreddits, about cryptocurrency from between 2005 and 2022. They also tracked the price of 30 mentioned cryptocurrencies.

There was a correlation for most cryptocurrencies between the level of conversation, compared with the previous day, and price. In that period, if someone had traded a cryptocurrency based on whether the number of posts rose, they could have made three times more than they invested (arXiv, doi.org/mc4w). **Chris Stokel-Walker**

Mind

Being better at navigation isn't down to evolution

MEN really do tend to have a better sense of direction than women, which is probably due to differences in how they were raised rather than being an evolutionary trait.

Previous studies have found that men slightly outperform women on spatial navigation tasks. Some researchers have suggested this may be due to evolution.

To investigate, Justin Rhodes at the University of Illinois Urbana-Champaign and his colleagues collected data from 21 species, including humans, that included information on spatial navigation skills and how far they travelled from their homes on average. If natural selection were at play, you would expect the sex that travelled further from home to have better navigational skills, with this being consistent across species.

Instead, the team found that among all the species, males were slightly better at navigating than females, even though in some species, such as the rusty crayfish (*Faxonius rusticus*) and the little devil poison frog (*Oophaga sylvatica*), the females had the larger home range (*Royal Society Open Science*, doi.org/mc4x).

The findings suggest that navigational differences in humans may be cultural. They could also be a side effect of biological variations between sexes. Hormonal differences, for example, "may affect all kinds of traits", says Rhodes.

"The authors show in a very comprehensive way that sex differences in spatial ability are more likely acquired," says Antoine Coutrot at the French National Centre for Scientific Research. "Spatial ability is much like all cognitive abilities: the more you use it, the more you have it." CL

Really brief

OLAF PROTZE/ALAMY

Warm weather turns ibex nocturnal

Alpine ibex (*Capra ibex*) are becoming more nocturnal to escape rising daytime temperatures, despite a higher risk of encountering predators. Tracking 47 ibex has revealed that when temperatures during daylight were higher, ibex were more active at night (*Proceedings of the Royal Society B*, doi.org/mc4p).

Mars has huge ice store at its equator

A colossal slab of ice seems to be hiding at Mars's equator. Data acquired by the Mars Express orbiter indicates that this deposit, called the Medusae Fossae Formation, contains enough water to cover the surface of Mars in an ocean 1.5 to 2.7 metres deep (Published in *Geophysical Research Letters*).

Multivitamins slow mental decline

Taking a daily multivitamin slows the rate of memory decline in older people. A trial compared placebos with supplements in 573 people who did memory tests at the study's start and two years later (*American Journal of Clinical Nutrition*, doi.org/gtd4p9). This is the third randomised trial to produce such a result.

Views

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Annalee Newitz contends with post-covid teaching p20

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Industry sets its sights on Bolivia's lithium reserves p22

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The Mediterranean diet is one of many options for health p24

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Culture columnist
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Comment

Why so squeamish?

Describing menstrual products using terms like sanitary towels reinforces the trope that menstruation is dirty. It's time to stop, says **Jen Gunter**

STORES sell most products intended for personal care by describing them based on their function. Toothpaste, bubble bath and toilet paper or tissue are some examples that come to mind. Based on those names, we have a good idea of their intended use.

However, there is one exception: menstrual products. If you wanted to buy tampons, pads or a menstrual cup, no one could fault you for being unable to find them in a store. This is because many use euphemisms on their signage, such as sanitary towels or napkins, or the more general "feminine hygiene products". Of course, this squeamishness isn't limited to store signs, and many people have been brought up to use these same euphemisms.

ELAINE KNOX

Let's dispense with the "hygiene" and "sanitary" aspects of these labels. These terms aren't just incorrect; they are harmful because they reinforce the tired trope that menstruation is dirty or polluting. This is a false belief that has been present for thousands of years and has been used to oppress women and keep them from being full members of society, for example by excluding them from religious services or from preparing food while menstruating.

Menstruation isn't unhygienic. When someone menstruates, they aren't dirty or unsanitary; they are menstruating. If we can say toilet paper – a product literally designed to wipe away faecal matter – without bringing up hygiene or sanitary concerns, surely we can do the same with menstrual products.

Then there is the "feminine" aspect. Menstruation doesn't confer femininity; how you feel about yourself is what matters there. Thinking back to my early days of buying pads and tampons, I remember being turned off by the feminine descriptors because, to me, the word feminine, especially when combined with the imagery used to sell these products, meant delicate or fragile.

I didn't see myself as delicate or fragile. I was a 14-year-old with plans to go places and do great things, who had no intention of limiting myself based on rules or ideas about my body created by men. There are also trans men and non-binary people who menstruate, so using feminine as an adjective excludes them. In addition, menstruation starts very early for some. Do we really want to use the term feminine for a product needed by someone who is 12 years old or even younger?

The easy fix here is to refer to tampons, pads or napkins, menstrual cups and menstrual underwear as menstrual products. That is their purpose. Nothing bad will happen to those who don't menstruate by seeing the words "menstrual products" on signage in a store or hearing them spoken. Menstruation isn't contagious.

This might seem like an insignificant change to some, possibly even an effort hardly worth the while, but it isn't. The inability to say or use a word in print implies it is shameful. When someone walks into a store to buy the products they need so they don't bleed all over their clothes and bedsheets and they are met with a euphemism, it reinforces the false narrative that what is happening is shameful and dirty.

Don't underestimate the negative impact this can have on someone. This isn't a once-in-a-lifetime purchase, but an experience they will repeat again and again. If we can ask for a roll of toilet paper or tissue, products that are destined to touch the genitals or anus, we can certainly see signs directing us to menstrual products, or even more specifically to tampons, menstrual pads or napkins, or menstrual cups.

The terms "sanitary napkins" and "feminine hygiene" aren't some thin line preventing society's decline. It is high time for the use of euphemisms for menstrual products to end, because there is nothing shameful about menstruation.

Jen Gunter is a gynaecologist. Her new book is *Blood: The science, medicine and mythology of menstruation*

This changes everything

The Rip Van Winkle of pedagogy

Returning to university teaching after almost two decades, **Annalee Newitz** discovers the trials and tribulations of learning management systems

Annalee Newitz is a science journalist and author. Their latest novel is *The Terraformers* and they are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is **techsploitation.com**

Annalee's week

What I'm reading
The Sentinel State *by Minxin Pei, a terrific deep dive into the Chinese surveillance state.*

What I'm watching
The Brothers Sun*, a hilarious series about a dorky guy who discovers his mother is actually the head of a Taiwanese gang.*

What I'm working on
Finishing my "new syllabus" for Intro to Media Studies in the learning management system.

This column appears monthly

IT IS never a good feeling to open a new piece of software and realise that something terrible has happened. The kind of terrible that results in dozens of instructional videos, hundreds of entries in the FAQs and multiple, contradictory warnings from people online purporting to give "simple introductions" to the software in question.

All of this and more happened to me when I found myself subjected to a learning management system (known not-so-fondly as an LMS) for teaching university classes in media studies. In a year when the US higher education system is imploding (more on that later), my journey through the wilds of this LMS felt practically allegorical.

Before I became a writer, I was an academic in American studies and I spent several years teaching at a university. I have always wanted to teach again, but I wound up taking almost two decades to get back to it. Hence my sudden LMS shock. I am the Rip Van Winkle of pedagogy, who fell asleep in a pile of smudgy photocopies and woke up in a world ravaged by plague-induced distance-learning platforms.

Back in the mists of time, I would create a syllabus and hand it out on a piece of paper on the first day of class. In a few rare cases, we had class websites and used some janky old chat software for online discussions. Mostly, there were books and photocopied "readers" full of supplementary materials. Exams were handwritten in "bluebooks", sheafs of lined paper stapled into flimsy blue covers.

I am not trying to evoke halcyon days. Books and readers were far too expensive and there was pretty much no way for students to collaborate, ask questions or turn in their work online. LMSes have gone a long way towards fixing those issues. In the department where I am teaching now, most course texts are cheap to access online. Students can chat with me and each other in the LMS and turn in exams and assignments online.

But now there is a new set of problems. An LMS is a commodity, which means it has to be something managers can buy for corporate instruction and on-the-job training. It has to be everything for everyone, which leads to redundancies and misnomers. "Don't ever use 'syllabus'," a colleague warned. "Use 'new syllabus' instead." Of course the drop-down menu includes both.

> **"Back in the mists of time, I would create a syllabus and hand it out on a piece of paper on the first day of class"**

Also, don't use "pages" or "files", I was told – use "modules". There are at least 50 videos on YouTube about how everything in this LMS (one of hundreds out there) has to be done with modules because everything else is broken. Which – yes, can confirm.

And then there are all the distance-learning features grafted onto an already bloated system in early 2020. I think this might be the source of a lot of problems in the LMS, which was converted from an already-messy system into a video streaming service that hosted thousands of professors broadcasting from home. That is a lot to ask of any piece of software.

Lurking beneath the tomfoolery is a stark reality: an LMS places educators and students under surveillance in a way that was quite shocking to me in my Rip Van Winkle state. I can see all my students' names, sure, but also their profiles, some of which include personal information. I can see when they logged in and what they did on the class site. And anyone the student shares their account with can see everything I am assigning in class, comments I have made in chat and more.

I like the idea that an LMS could lead to transparency and accountability. But I worry that isn't how this kind of detailed classroom information is being used. In the US, there is a backlash against higher education right now. Recently, conservatives proudly proclaimed that their anti-diversity activism led to the resignation of Claudine Gay, the first Black woman to become president of Harvard University. Parent groups are banning books in school libraries and pointing at "woke" syllabi to accuse professors of brainwashing students by teaching the history of slavery, for example. People who hate the idea of liberal education are selectively surveilling classrooms and weaponising what they find. Of course, parents and activists could always find out what was being taught in school, but LMSes make it far easier by collecting it all in one place and putting it online.

Needless to say, the texts that an educator assigns are just a small part of what they teach. I would hate for my classes to be judged purely on what students are assigned; sometimes I teach texts I want to question or eviscerate in order to model critical thinking. That is the problem with peeking at a class in an LMS and assuming you know what is being taught.

This brings me back to the LMS as an allegory for education in the US. It has been commodified, it is messy and it is full of surveillance features. Luckily, it works just well enough for us to teach – and we have to hope that is enough. ▮

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Battery blues

Photographer **Matjaž Krivic**
Agency **Institute Artist**

THIS eerily beautiful place is Salar de Uyuni, the world's largest salt flat. It lies at the crest of the Bolivian Andes and covers over 10,000 square kilometres. But below its stunning surface, trouble is brewing. The demand for electric vehicles and the lithium batteries they require is booming, and Bolivia wants to exploit its lithium resources. The country's state-owned mining company opened its first industrial-scale lithium plant (pictured below), near Uyuni in December 2023.

Photographer Matjaž Krivic has been visiting the area since 2016, charting the effects of lithium mining. His photograph of the flat was taken with a drone in 2017 and shows local salt miners loading their truck with salt. Krivic says the evaporation ponds of lithium production facilities will draw heavily on the region's scarce freshwater, and that llama herders and quinoa farmers are worried.

Ten years ago, Bolivians were talking about their country becoming the Saudi Arabia of lithium, says Krivic. "This has taken a long time, but now they've opened their first industrial-scale lithium plant, the problems for locals around water shortages will really start."

Alison Flood

Editor's pick

Mediterranean is just one of many great diets

13 January, p 32

From Justine Butler, Bristol, UK

Michael Marshall's look at the Mediterranean diet made one key observation I wish he had expanded on. He described how one scientist said different regions of the world may have their own optimum diet. This is what longevity researcher Dan Buettner found in his study of so-called blue zones, where there are high levels of centenarians. One is in Sardinia, in the Mediterranean, but the other zones are far from it.

From one side of the planet to the other, blue zone inhabitants share some striking similarities that can be adapted to suit anyone. Their diets are plant-based and moderate, most have a drink in the evening and they move about a lot by gardening, cooking, playing games or exercising. They find ways to reduce stress, find a purpose in life, offer and receive support and, perhaps most importantly, find their tribe. We could learn a lot from them.

It really does take a village to raise a child

6 January, p 40

From Margaret Wilkes, Perth, Western Australia

As a psychologist and a mother who struggled in the early months of my babies' lives in the isolation of suburban Australia, I found Tina Knezevic's article on postnatal anxiety very interesting.

While research into the biological causes of this will continue to make progress, I agree that the condition is "a function of biological, psychological and social factors". Having travelled and worked in lower-income countries, I suspect that this anxiety is less prevalent in more collectivist societies. It has been said that "it takes a village to raise a child"and a new mother in a nuclear family will typically have had little experience with infants before she gives birth to her own.

The huge responsibility of caring for this vulnerable infant, while typically lacking physical and emotional support from other mothers who may also be struggling with isolation, means anxiety is likely to be high. I look forward to cross-cultural studies on this important topic.

Electric cars may hold the solution to grid shortages

6 January, p 13

From Brad Elliott, Sydney, Australia

You point out that electricity shortages will probably develop during peak periods in areas of North America, in part due to the lack of new transmission lines to connect new sources of renewable power to population centres. There are similar concerns in Australia.

However, little has been written about the hidden power of electric vehicles to help. Surprisingly, EV batteries typically have more than four times the energy capacity of the largest home battery systems. Most EV owners only use a small fraction of that capacity each day, other than on the rare occasions when they need to make a long journey. Newer EVs are now able to export power to the home.

Increasing numbers of EV owners could charge their cars using renewable energy or off-peak energy and then use their car to power the house during peak periods. This could substantially reduce demand for new power lines and improve grid reliability.

Reflections on the idea of mirror matter

6 January, p 18

From Sam Edge, Ringwood, Hampshire, UK

I was interested to read about some potential consequences should dark matter consist of "mirror matter". However, if this exists as a mirror duplicate of all particles and the electromagnetic, weak and strong forces, I question why gravity would be the same for mirror matter as for conventional matter, which it would have to be if mirror matter is dark matter.

Dark matter is usually postulated as material that interacts normally in terms of mass and gravity, but very weakly in terms of the other forces. A simpler answer would be that it is conventional matter of a form not covered by the standard model of particle physics, rather than a whole mirror copy of everything we already have except gravity.

Is the Anthropocene far older than we thought?

30 December 2023, p 15

From William Hughes-Games, Waipara, New Zealand

The beginning of a new epoch has often been defined as when, in a continually deposited sequence of sedimentary rock, an assemblage of animals largely disappears, allowing a new assemblage to evolve, usually evidenced by fossils. The implication is that some catastrophic event wiped out much of the older group.

Using that definition, the Anthropocene began in Australia some 50,000 years ago with the demise of much larger marsupials. Likewise, it started in the Americas some 11,000 or 12,000 years ago and in New Zealand about 700 years ago, in both cases with the wiping out of megafauna and many smaller animals. If, on the other hand, we use the definition of a change in the climate, looking at the previous handful of glacial-interglacial cycles, we should now be having ice accumulating on the highlands of Baffin Island and beginning to spread southwards. In this case, the Anthropocene began about 8000 years ago.

For every silver lining, there is a cloud

30 December 2023, p 34

From Roy Harrison, Verwood, Dorset, UK

Hannah Ritchie highlights the progress made in developing and deploying new energy sources and more efficient machines, but while such headway is welcome, every silver lining has a cloud.

Most of the graphs published with the story are of carbon dioxide per person, but what matters is total emissions, as population growth reduces gains made.

When every thousandth of a degree counts

Letters, 6 January

From John Rymell, London, UK

I suggest we start stating global average temperature rises in millikelvin instead of degrees Celsius, in which case we would refer to our strictest global warming target as a 1500 mK rise. This sounds more serious than 1.5°C, so might persuade far more people to take serious notice of, and act more quickly on, the crisis.

Reverse causation for this covid-19 link?

13 January, p 16

From Andrew Taubman, Sydney, Australia

You report that people with a severe covid-19 infection are more likely to be diagnosed with schizophrenia, suggesting that covid-19 heightens the risk of this condition. Alternatively, could people with undiagnosed early schizophrenia be more likely to catch covid-19, perhaps due to some characteristic behaviours? ▮

Want to get in touch?

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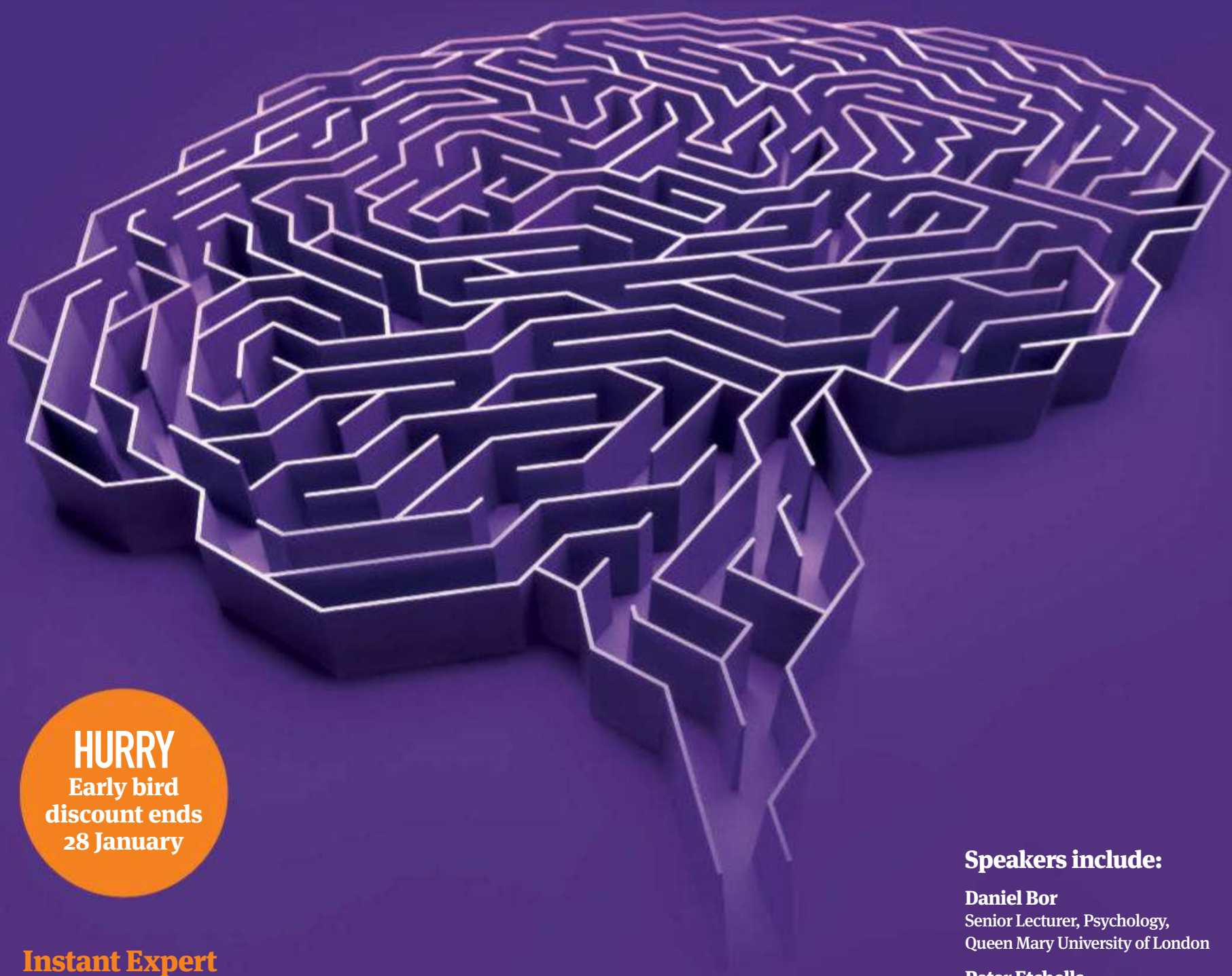

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Against the odds

Katalin Karikó's work on mRNA was dismissed for years before it led to life-saving covid-19 vaccines. **Clare Wilson** follows her path to a Nobel prize

TT NEWS AGENCY/ALAMY

Katalin Karikó receiving her Nobel prize in Stockholm in 2023

Book

Breaking Through

Katalin Karikó

Bodley Head (UK); Crown (US)

IN OCTOBER 2023, the Nobel prize in physiology or medicine went to Katalin Karikó for helping to lay the groundwork for mRNA-based covid-19 vaccines, alongside her collaborator, Drew Weissman. Yet only a few years earlier, Karikó's career had been spoken of "in hushed tones as a cautionary tale for young scientists".

Karikó's story is a classic in the genre of underdogs succeeding against the odds. In her autobiography, *Breaking Through: My life in science*, she dishes the dirt on those who overlooked and underestimated her for decades, particularly staff at her chief workplace, the University of Pennsylvania in Philadelphia.

In the 1980s, Karikó had recently emigrated to the US from Hungary and was struggling with a very different workplace culture, having scored a job at the prestigious "Penn". She had spotted the promise of mRNA, a molecule that cells use to make proteins from the information stored in their DNA. While mRNA was infamously unstable and difficult to work with, it could, in theory, be used to make cells produce any proteins you like.

But Karikó couldn't convince the usual funding sources, such as the US government, to give her grants to discover how to harness this resource. After five years without securing a grant, Karikó was demoted from the academic career ladder.

Anyone who had previously suffered this fate had left Penn, but Karikó carried on in a low-status position, scrabbling around for laboratory reagents. She even made her own lab flasks from oversized pickle jars.

There were bright spots. A few individuals gave her help and encouragement. After a chance encounter at a photocopier, Karikó struck up a partnership with Weissman, then an HIV vaccine researcher, and switched her focus from mRNA-based medicines to vaccines. Together, they made a key breakthrough, discovering how to modify artificial mRNA so it is accepted by our cells without a destructive immune response.

The technology was licensed by two small biotech firms: Moderna, based in the US, and BioNTech in Germany, where Karikó took a job. When covid-19 struck, mRNA was an obvious choice for vaccines because new mRNA molecules can be designed and mass produced faster than the components of most other kinds of vaccine. The rest is pandemic history.

"Scientists are judged mercilessly by metrics – the number of papers published, the prestige of journals they are in"

But it is sobering to consider how close we came to not having that technology. Why was it such a near miss? An autobiography is necessarily a one-sided account, but Karikó is scathing about the workplace culture at Penn, where, in her view, self-publicity and sycophancy seemed essential career skills and who you knew beat what you knew.

Yet wider issues may also have come into it. Perhaps the current grant-awarding system is too focused on applied research – which seeks to answer specific questions with fast pay-offs – rather than basic science, which explores deeper questions in the hope a use will turn up sometime.

There is a more fundamental problem with how universities are run, though. Scientists are judged mercilessly by metrics such as the number of papers they have published, the prestige of the journals in which these appear and their impact – how many times their papers are cited by others.

Such an approach may keep bean counters happy, but can be gamed by the unscrupulous and may not gauge a scientist's true abilities. Karikó wasn't valued at Penn because she scored zero on its dollars-per-square-foot scale, a measure of how much grant money a scientist brings in compared with their lab space.

The key question is how we can change the system to ensure we don't overlook people like Karikó, according to Stuart Buck at the Good Science Project, which aims to improve the funding system.

Considering how many lives have been saved by the mRNA covid-19 vaccines, it turns out that Karikó's story is a cautionary tale – just not the one that her university thought it was. ▮

Cultural takeover

Algorithms are robbing us of agency and identity, says a disturbing new book. But there are ways to resist, discovers **Alex Wilkins**

Book
Filterworld
Kyle Chayka
Doubleday Books

IT MAY seem a truism to say that our lives are ruled by algorithms – doomscrolling and filter bubbles have entered the lexicon – but have we really collectively reckoned with how they have transformed our culture and personalities?

In *Filterworld: How algorithms flattened culture*, Kyle Chayka, a staff writer at *The New Yorker* magazine, argues convincingly that the shift towards algorithmically curated feeds, used everywhere online from Instagram to Spotify, has homogenised culture. Our tastes and desires increasingly don't belong to us, but to algorithms that are designed to keep people engaged at all costs.

If the sum total of your tastes does indeed add up to an entire personality, then this loss is more psychologically wounding than it first appears. Idly scrolling through Netflix or TikTok may seem harmless, but over days, months or years, something more insidious occurs. We lose our grip on what we like and enjoy, outsourcing our taste to the machine. Chayka writes that "developing or indulging [taste] means constructing a firmer sense of self, it becomes the basis for identity". Without it, he implies, we are adrift.

Taste-making algorithms are inescapable. Chayka shows this by working through all corners of life: what we wear (TikTok), where we eat (Google Maps), music we listen to (Spotify), even who we date or marry (Tinder). Though many of his observations aren't unique, taken together they seem to me to become what philosopher Timothy Morton calls a hyperobject, an incomprehensible edifice, dwarfing a human's sense of time and scale.

Chayka argues that this universe of algorithmically driven decisions he calls Filterworld has society-wide implications: "It scales up to influence our physical spaces, our cities, and the routes we move through… flattening them in turn."

No one gets out of Filterworld unscathed. If you are lucky enough not to need any sort of algorithm-based system for your work – which instantly excludes almost every creative industry that relies on these feeds for promotion – then you can try opting out of the algorithms for a while. You can peruse a physical bookstore rather than BookTok – TikTok book recommendations – or turn on the radio instead of Spotify's Discover Weekly playlist.

But if your friend suggests a film recommended on X/Twitter or you feel the need to buy those shoes everyone has inexplicably started wearing after a social media hype cycle, what are you to do? There is a sense of futility about it all,

Just finding out more about a book or film may help resist the algorithms operating in our world as Chayka finds when he tries his own algo-detox for a few months.

This Filterworld may feel inescapable, then, but there is hope, and Chayka has some reasonable suggestions about how to alter things. Leaving aside the systemic changes to big platforms that are the domain of government regulation and the law, people can at least be conscious consumers. Shifting big problems to individuals can seem dubious when, for example, we are told to reduce our carbon footprint while oil companies are let off the hook, but it can give us a sense of agency when it comes to tastes.

This can be as simple as engaging more with the media you do choose to consume by, say, reading up about a film you watched or by paying artists you like directly, says Chayka. Even the thoughtful act of recommending an album to a friend is infinitely more rewarding than a contextless track surfacing in your Spotify feed. As Chayka says, resistance to algorithmic frictionlessness "requires an act of willpower, a choice to move through the world in a different way. It doesn't have to be a dramatic one."

BRUNO GIULIANI/ALAMY

New Scientist *recommends*

Thomas Lewton
Features editor
London

I have just finished the TV adaptation of Naomi Alderman's science fiction novel **The Power** (pictured, on Amazon Prime Video), in which a biological quirk causes society to unravel. Young

women begin generating electricity in a once-dormant organ, learning how to shoot sparks from their fingertips.

The global balance of power shifts overnight, as told through half a dozen parallel storylines set in different countries. We see revolution in the Middle East, near-biblical resurrection in the US and revenge in eastern Europe – with all the stories posing questions about the purpose and corrupting potential of physical power.

I am also nearing the end of Kazuo Ishiguro's sci-fi novel **Never Let Me Go**. The setting appears to be an English private school in the 1990s, but in this alternate reality, mass human cloning is the norm. Everyday squabbles are interspersed with a dawning realisation of the twisted role the children will have to play as "donors". Terrifying.

LUDOVIC ROBERT/AMAZON PRIME VIDEO

New Scientist video
Watch our interview with Simon Reeve about his new travel show at **youtube.com/newscientist**

The TV column

Armchair travels Some urbanites feel like nature-travel shows almost come from another planet, while others worry they encourage harmful tourism. Luckily, Simon Reeve's excellent new series puts conservation to the fore, says **Bethan Ackerley**

Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. She is still upset about the ending of *Game of Thrones*. Follow her on Twitter @inkerley

BBC/THE GARDEN/JONATHAN YOUNG

Simon Reeve travelling up a river in the Republic of the Congo

AS A committed urbanite, I would never swap the industrial chic of my home city of Wolverhampton, UK, for a vista of rolling hills and dales, let alone tropical rainforests or mountain peaks. For me, and for billions like me, the glories of untamed nature feel a planet away.

Wilderness with Simon Reeve, a four-part BBC travel documentary, aims to fill this gap. Reeve and his crew seek out corners of our rapidly urbanising globe so far relatively untouched by humanity. Travelling across rainforests and ice fields, deserts and oceans, including the Pacific Ocean's Coral Triangle, and Patagonia, they reveal the pressures there and how we might protect them – from us.

Travel programmes have a rather queasy relationship with conservation, predicated as they are on "selling" a destination. When it comes to the places least influenced by humans (the idea of "pristine" nature is an enduring, appealing myth), I am wary that glossy travelogues can lead to mass tourism and damage.

Happily, based on its first episode, *Wilderness with Simon Reeve* seems more about finding a balance between "right" and "wrong" kinds of tourism. In this instalment, we visit the Congo basin, home to the world's second-largest tropical forest, which stretches for more than 2 million square kilometres across central Africa. The three-week journey begins along the Republic of the Congo's Motaba river in search of the Baku, hunter-gatherers who live nomadically in the jungle.

> **"The series makes a strong case that the first step to preserving an ecosystem is to see its value"**

After an old-fashioned knees-up to welcome Reeve, several young Baku men agree to take a camera as they climb 20 metres into the tree canopy. One man thrusts his arm into a beehive and extracts a luminescent haul of honeycomb.

This is just one example of the extraordinary nature in the Congo rainforest. For me, it epitomised the joy and surprise I felt learning about this region and its people, who aren't treated as quasi-mystical custodians of arcane knowledge, but as an adaptable, conscientious community moving with the times.

The Baku face a huge risk from deforestation: not only has it brought them into hostile contact with neighbouring villages, it has also forced them to venture into areas where mosquitoes thrive. If someone contracts malaria, the group can sometimes be four days away from medical care, meaning child mortality rates are high.

In this first leg, Reeve is joined by Adams Cassinga, a wildlife criminal investigator who runs a network of informers working to prevent illegal forest clearances. He steals the show, especially when he scrutinises African redwoods for illegal felling.

Once Reeve and the team cross into the Democratic Republic of the Congo, they look for bonobos. Here, the show feels more like a traditional travel series, all boiling heat and swarms of insects.

But despite the difficult trek, Reeve provides an ebullient precis of the importance of these apes, one of our closest relatives. The peaceful, largely female-dominated social structure of bonobos hints at a different side of human evolution compared with their cousins, the chimpanzees.

All told, the first episode is informative and entertaining. I still have reservations about the impact of such travel shows on conservation, but the series makes a strong case that the first step to preserving an ecosystem is to see its value. *Wilderness with Simon Reeve* does that in spades. ▮

TV
Wilderness with Simon Reeve
The Garden (for the BBC); no US release date announced

Bethan also recommends...

TV
Back from the Brink
BBC iPlayer
This uplifting two-part series highlights amazing conservation wins in Europe, such as the comeback of Scotland's capercaillie.

Film
A Crack in the Mountain
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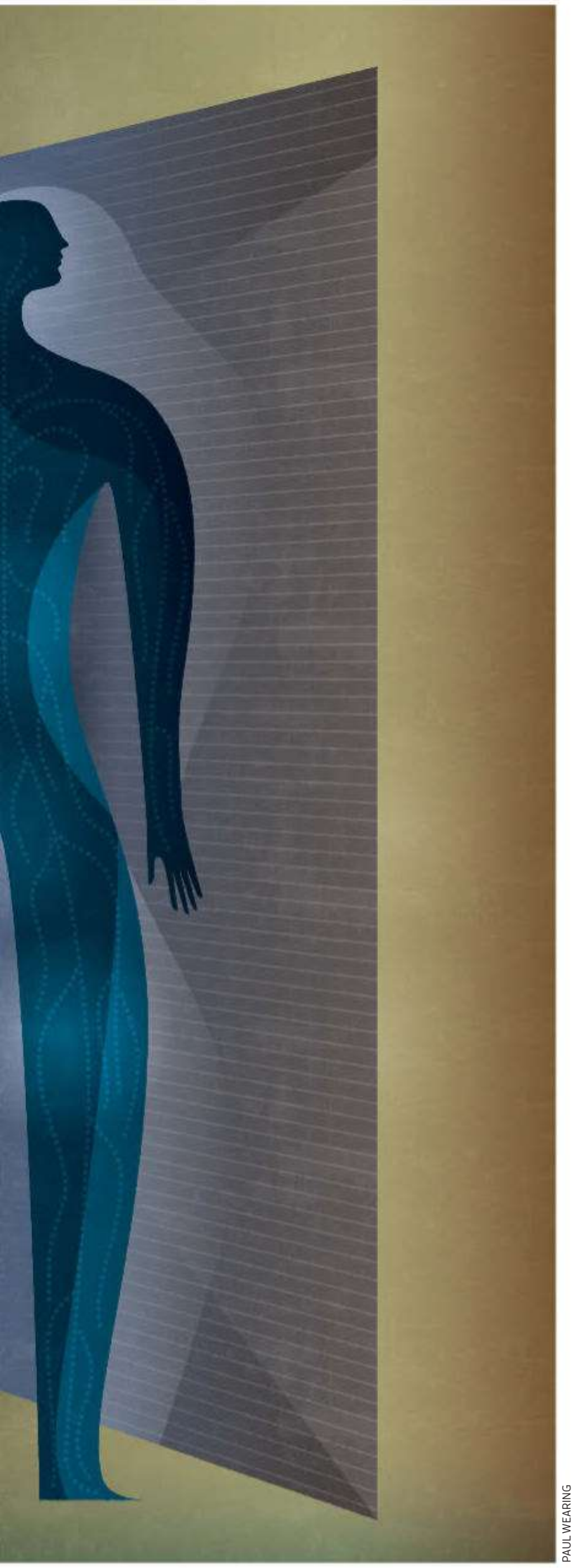
MYSTERIOUS YOU

The human body is incredibly complex, with the latest estimates suggesting we each contain some 400 different kinds of cells across 60 different tissues. Science has given us an intimate understanding of their intricate workings, revolutionising our understanding of health and disease – and the evolutionary marvel that is you. But your body still contains mysteries.

Over nine pages, we explore some of the most baffling of these and the extraordinary insights they are throwing up. We investigate the true purpose of blood types and the taste receptors in our hearts. We discover how the menopause may have evolved to ensure the survival of future generations and the remarkable roles that cells transferred from mother to baby, and vice versa, play in keeping us healthy. We even sniff around the latest thinking on the controversial idea that we give off secret chemical signals capable of influencing the behaviour of other people.



PAUL WEARING

WHY DO WE HAVE MENOPAUSE?

AROUND the age of 50, women stop releasing eggs and can no longer have children. We consider this menopause a natural part of life, but in one respect, it is really rather unusual – there are hardly any other species in which females experience reproductive shutdown when they typically still have decades of healthy life ahead.

So what is the point of menopause? The latest findings support the idea that it is to do with our uniquely demanding offspring and the need to keep relatives who could care for them healthy and mentally sharp for as long as possible.

Classic evolutionary theory predicts that organisms should only live as long as they can pass on their genes. This mostly holds true across the animal kingdom: besides humans, only female orcas, short-finned pilot whales, belugas and narwhals tend to survive well beyond their fertile years.

The reason we have menopause may simply be because there are biological constraints on how long it is possible to maintain high-quality eggs, says Michael Gurven at the University of California, Santa Barbara. The average age of the onset of menopause in humans has barely budged even as life expectancy has soared, he says. "We definitely seem to be hitting a wall."

Men may not experience the same clear-cut end to their fertility because they can keep creating new sperm as they age, albeit with declining quantity and quality, whereas women are born with all their eggs, which accrue DNA damage over time, says Gurven.

Indeed, "the thing to really explain is not why women have menopause, but why they live so long after menopause", he says. Over the past decade, evidence has been building to explain this unique characteristic – and the benefits it has for our evolutionary success.

Our best ideas are based around the "grandmother hypothesis" – the notion that once women can no longer have children of their own, they can help look after any grandchildren, who each carry 25 per cent of their genes. This may be particularly relevant for humans because we have unusually helpless young, says Gurven. "If you look at our nearest relatives, chimpanzees, they can largely feed themselves by the time they're 6 [years old]," he says. "With humans, it often takes up to two decades for us to be self-sufficient."

Grandparents can come to the rescue by providing extra food for their grandchildren or taking care of them while their parents are out foraging or nursing younger children, he says.

Recent evidence suggests we are on the right track. A study Gurven published in 2022 with Raziel Davison, also at Santa Barbara, showed that in many hunter-gatherer groups, like the Hadza of Tanzania and the Aché of Paraguay, adults over the age of 50 boost the survival and fertility of younger generations by sharing resources. This contribution ultimately allowed grandparents to pass on more of their genes. "Our modelling suggested it was equivalent to having up to three more children," says Gurven. ›

Orcas and short-finned pilot whales also have highly dependent young, which may explain why females have similarly long post-reproductive lifespans. Studies of wild orcas have found that post-reproductive females lead expeditions to find sustenance and increase the survival of their grand-offspring by sharing food and knowledge of where to forage. Male offspring also suffer fewer socially inflicted injuries in the presence of their post-reproductive mother.

Ajit Varki at the University of California, San Diego, believes he and his colleagues have also found genetic evidence to bolster the grandmother hypothesis. In 2015, his group found a variant of an immune gene called *CD33* that is protective against late-life Alzheimer's disease and is found in 20 per cent of modern humans, but not in chimpanzees or our closest extinct relatives, Neanderthals and Denisovans.

This variant may have been selected for as our period of infancy evolved to become longer, says Varki. By protecting people from Alzheimer's disease, the new *CD33* variant may have helped keep them healthy for longer so they could pitch in with providing food and care for helpless grandchildren, he says.

"Women play such an important role after menopause that genes evolved to protect their minds"

Since then, Varki and his colleagues have uncovered more than 10 additional genetic variants that appear to protect against cognitive decline. This suggests that women play such an important role after menopause that we even evolved genes to protect their minds, says Varki.

While these findings may not help with enduring the hot flushes and night sweats that can accompany menopause, it may be some comfort to know that these unpleasant symptoms mark the beginning of an important life chapter that probably helped shape our evolutionary success. **Alice Klein**

WHAT ARE ALL THOSE FUNGI DOING IN OUR GUTS?

WE ARE all a bit mouldy – literally. Our bodies are home to a great many fungi. They are scattered on our skin, inside our mouths and in our guts. Some of them have adapted so well to life in the human body that they can't survive anywhere else. But we know very little about this "mycobiome" and what it is doing.

We know the fungi are there and we have read their DNA, but in the past it hasn't been clear if they offer us any benefits or are mainly passive hitchhikers, with the odd infection-causing interloper. Now, though, a boom in interest in the bacteria that reside in our guts has spurred researchers to take a new look at fungi too, with an eye to unravelling the secrets they hold.

What they are finding is that our fungal residents can have a significant influence on our health, raising the prospect that we could manipulate them to boost our resilience against disease.

The good news is that we aren't starting from scratch. For a start, we know that the fungi in our bodies are less diverse than the bacteria within us, probably by around a factor of 10, says Lindsay Kalan at McMaster University in Ontario, Canada. We also know that certain fungi crop up consistently. For instance, a genus of yeast called *Malassezia* makes up the majority of the species on our skin, says Kalan.

Until recently, the extent to which our mycobiomes differed was largely unknown. But new evidence suggests they can vary to a significant extent, particularly as we age, with implications for our risk of certain diseases. A 2023 study examined samples of gut fungi taken from 3363 people across three continents and found they could be clustered into four groups. Certain groups of fungi had a strong age preference – for instance, one group dominated by *Candida* was more likely to be found in older people, where it

PAUL WEARING

was linked with an increased risk of multiple diseases associated with a compromised intestinal barrier, such as some cancers, bowel disease and diabetes. Similarly, in work described in his book *Total Gut Balance*, Mahmoud Ghannoum at Case Western Reserve University in Cleveland, Ohio, identified six such groups of gut mycobiome.

Every fungal species in our bodies is arguably a "pathobiont", meaning they all have the potential to cause infection, says Kalan. However, the risks they pose depend both on the species and on our own level of vulnerability: a fungus that is a minor inconvenience for one person can be lethal for someone else.

One of the most dramatic examples is a yeast called *Candida auris*, which was first identified in Japan in 2009. Since then, it has spread at an alarming rate, primarily in healthcare facilities, where it has found many hosts with weakened immune systems. It is resistant to an increasing number of treatments, which helps explain why mortality rates are estimated at 30 to 60 per cent. "The prevalence of infection is very low," says Kalan, "but it's still a very high risk if you do end up with one of these infections."

There is also evidence that gut fungi can exacerbate and prolong viral infections, such as covid-19. Recently, a team led by Iliyan Iliev at Cornell University in New York found that people with severe covid-19 also had elevated levels of *Candida albicans* in their guts. This triggered an explosion of white blood cells called neutrophils, which are a vital part of the immune response, but can make it harder to recover from illnesses when present in high numbers. This immune system signature could still be detected a year later. "There is a link with long covid, but it's not like the fungus is causing the long covid," stresses Iliev. Instead, the two are interacting in some way that we have yet to fathom.

We are, however, developing a better understanding of how changes to gut fungi can affect other conditions. For instance, Ghannoum and his colleagues have found that interactions between gut bacteria and fungi can play a role in Crohn's disease. When living alongside certain bacteria, a normally benign fungus called *Candida tropicalis* starts to form tiny thread-like structures called hyphae that release enzymes and absorb nutrients. "We found it starts to poke holes in the gut lining," says Ghannoum. Similarly, in 2022, Iliev's team showed that some strains of *C. albicans* in the gut are involved in inflammatory bowel disease.

Kalan is also investigating how fungi and other microbes interact on our skin. Her group studies chronic wounds like diabetic foot ulcers, which heal very slowly. The team found that *C. albicans* in such wounds can be triggered to form hyphae by bacteria called *Citrobacter freundii*. This leads to more severe infections and inflammatory responses.

There are even tentative links between our mycobiome and cancer. In 2017, Ghannoum's team found that people with a particular kind of tongue cancer had an unusual mix of microbes in their mouths: the bacterial and fungal communities were both altered compared with those in people without this cancer. But the researchers don't know what the causal mechanisms are, which Ghannoum says is typical of fungus-cancer studies. "A lot of it is still correlation."

At this point, it may seem like our mycobiome is nothing but a source of problems. However, fungi can be beneficial, at least some of the time. The yeast *Saccharomyces boulardii* helps prevent antibiotic-associated diarrhoea, for instance, and the related baker's yeast *S. cerevisiae* can control vaginal thrush by suppressing *C. albicans*.

There are sure to be more benefits, but we haven't paid much attention to the upsides of bodily fungi. "A lot of focus has been on how are they making us sick and how is it contributing to other diseases," says Kalan.

But we may yet conclude that we can manipulate the mycobiome for the benefit of our health. Like the bacterial arm of our microbiome, the make-up and diversity of fungi in our gut can be shaped by diet. Carbohydrate-rich food is correlated with an increase in *Candida* species, for example. We are far from being able to recommend a mycobiome-boosting diet, but given the impact our microbiome has on well-being, it is likely that we will start seeing such research soon. **Michael Marshall**

Cells from grandparents live on in you

HALFPOINT IMAGES/GETTY IMAGES

WHY DO CELLS FROM YOUR EXTENDED FAMILY SETTLE INSIDE YOUR ORGANS?

IN THE 1990s, Diana Bianchi at Harvard University and her colleagues made a peculiar discovery. They found that women who had given birth to boys up to 27 years earlier still had their sons' cells circulating in their blood. "We were very surprised – it really changed our thinking about pregnancy," says Bianchi, who is now director of the US National Institute of Child Health and Human Development in Maryland.

Other groups later found mothers' cells in their children's blood, even when the children had become young adults. Together, these findings suggest that while we are in utero, a small proportion of our cells cross into our mothers and vice versa, then stick around for decades.

But this goes even further because it is thought that we also harbour cells from older siblings, uncles, aunts and grandmothers. One study of 154 Danish girls, aged 10 to 15, found that 14 per cent of them had male cells circulating in their blood. This was more likely to be the case if they had an older brother. This could occur if a mother absorbed cells from her son while he was in utero, then passed those cells on to her daughter during a subsequent pregnancy. In theory, if the daughter later passed her brother's cells on to a child of her own, that child would carry their uncle's cells. ›

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Such effects can also be seen years after pregnancy loss. And we are only now starting to realise the extraordinary impact these cells can have, not only on our health but our behaviour too.

For instance, studies have found higher levels of these cells in the blood of people with certain autoimmune conditions, suggesting they may trigger reactions, even if a causal link is yet to be established. Meanwhile, increasing evidence suggests that these cells also play an important role in repairing tissue damage and combating disease.

Some first clues were uncovered by Bianchi and her colleagues while studying biopsies from women with thyroid disease. Part of the thyroid from one woman was entirely male, says Bianchi. They believe the male cells came from the woman's son in utero and were subsequently helping to repair her damaged thyroid.

Similarly, Keelin O'Donoghue and Uzma Mahmood at University College Cork in Ireland discovered male cells in the Caesarean scars of women who had birthed sons by C-section and found signs that these had assisted with the healing process. Cells from female fetuses possess the same healing properties, but it is easier to look for male fetal cells in mothers because they carry the distinctive Y chromosome.

Remarkably, Hina Chaudhry at the Icahn School of Medicine at Mount Sinai in New York and her colleagues found that when the hearts of pregnant mice are damaged, cells from their fetuses travel to the injury. There, they transform into beating heart cells. This may explain why some people with heart failure spontaneously recover while pregnant, says Chaudhry. "My theory is that there's an evolutionary mechanism whereby the fetus protects the mother because it has to protect its home."

The transfer of cells the other way, from mother to fetus, also seems to be beneficial. For example, during an autopsy, J. Lee Nelson at the Fred Hutchinson Cancer Center in Seattle and her colleagues found female insulin-producing cells in a pancreas from an 11-year-old boy whose body hadn't been able to produce insulin on its own. The female cells appeared to have come from his mother and were attempting to help regenerate his malfunctioning pancreas.

These cellular souvenirs from pregnancy have now been identified in every organ studied. Some of the most intriguing discoveries are being made in the brain. Most recently, there have been signs that fetal stem cells colonise parts of the brain responsible for emotion and behaviour and turn into neurons that form new connections with the mother's own brain cells. What they do then isn't clear, but researchers hypothesise that these structural changes may play a role in the mother's ability to love and care for the child.

There is clearly much to discover, but it appears we should be happy to have this menagerie of cells from different generations inside us. It means that we always carry little pieces of them around with us, keepsakes that can change our behaviour and safeguard our health. **AK**

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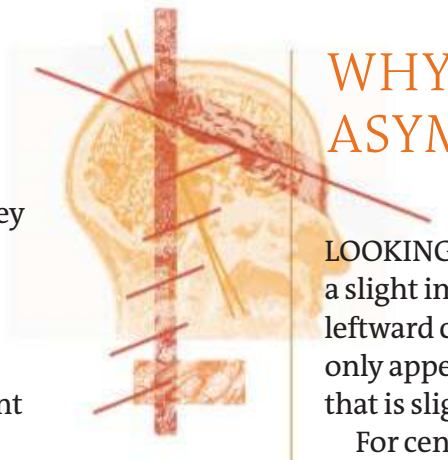


WHY ARE WE SO ASYMMETRICAL?

LOOKING in the mirror, you may notice a slight imbalance in your features – a leftward curve of the nose, a wrinkle that only appears under one eye or an ear that is slightly higher than the other.

For centuries, this lack of perfect balance was thought to detract from our beauty, and you can find many services, from photo filters to cosmetic surgery, that aim to "correct" it. Yet asymmetry is built into the human body and brain – and for good reason. What's more, new research suggests that it has little influence over our appeal to others.

Let's start with the lopsided arrangement of our internal organs. For most people, the heart, stomach and spleen all fall to the left of the spinal cord, while the liver and gall bladder fall to the right. This makes more efficient use of the space in our thorax and abdomen, compared with a structure aligning every organ with the spine.

How about the brain? Its two hemispheres may appear to be reflections of each other, but the corresponding regions on each side have different responsibilities. You will have noticed the effects of this on your movements. If you are right-handed, that is because the left hemisphere of your brain – which is wired up to the right side of the body – has become slightly more specialised in the fine muscle control of your fingers, giving you greater dexterity in that hand.

It may surprise you to discover that this "lateralisation" can be found in many other behaviours. Most of us have a dominant ear or eye, for example (see "Are you left or right-eyed?", above). "If you peek through a keyhole, then the majority of people would use their right eye, regardless of where the keyhole is – whether it is on the left or on the right side of the door," says Onur Güntürkün at Ruhr University Bochum in Germany.

He argues that lateralisation speeds up the neural changes associated with learning. If, when growing up, we use both hands for dexterous tasks, then the effects of that training will be split across the two hemispheres. If, however, we only use one hand, then the effects of that training will be focused on a single

Are you left or right-eyed?

Put your arms out in front of you and make a triangle with your thumbs and forefingers. With both eyes open, centre this triangle around a distant object – a clock or a doorknob, say. Close your left eye. If the object barely moves, then your right eye is dominant. If the object is no longer framed, then the left eye is top dog. Your brain combines information from both eyes to help you perceive the world, but preferentially uses information from one eye over the other – although emerging research suggests this may be task dependent.

hemisphere – leading to quicker neural specialisation and faster progress. The same logic applies for sensory processing. "The more we train our visual cortex to see certain patterns in complex pictures, the better we get at it," says Güntürkün. And you maximise this advantage by ensuring that the majority of the practice goes into developing just one side of the visual cortex.

How about facial asymmetries? At conception, our genomes plan for our external features to develop in perfect proportion to each other. However, we all face stresses – such as illness – that can create tiny perturbations in our growth that deviate from this blueprint. These result in the slight asymmetries that we observe in the mirror.

According to the "good genes" hypothesis, people with better genetic health – governing their immune system, for example – develop fewer imperfections during development, with more symmetrical faces. Facial symmetry should therefore be more attractive to people looking for a mate with good genes to pass on to their offspring. The hypothesis has become a law unto itself after a lot of early research seemed to support it.

"We couldn't find any relationship between facial symmetry and physical allure"

However, none of these predictions has stood up to the scrutiny of recent research. Facial symmetry doesn't seem to be related to physiological factors like immune function and – even more damningly – it doesn't seem to increase people's physical allure. In one experiment, Alex Jones at Swansea University, UK, and Bastien Jaeger at Tilburg University in the Netherlands asked participants to rate photos of people with various levels of facial asymmetry. "We couldn't find any relationship," says Jones.

He points out that preferences will vary greatly from person to person, but symmetry doesn't seem to be an important factor for most people. Beauty, it seems, really does lie in the eye of the beholder. **David Robson**

DO HUMAN PHEROMONES EXIST?

YOU may think you can mask it with a shower and a bit of deodorant, but every time you walk into a room, a whiff of your body odour drifts in your wake. It might be musty, mouldy, milky and metallic, or oily, heavy and animalic – these are just a few words that trained perfumers have used to classify the different "flavours" of natural BO.

While it is clear that odour and perfumes can alter the moods of those around you, it remains a mystery whether there are any unique agents produced by the human body, namely pheromones, that specifically alter other people's mood, behaviour or physiological arousal.

The idea makes sense. We know that other mammals use pheromones for communication and that they play an important role in mating. But after a flurry of studies hinted that humans shared this trait, researchers started to pick holes in the data and the idea seemed to be left to rest. Quietly, though, a handful of researchers are still digging away, with some tantalising findings suggesting that the pursuit isn't in vain.

The hunt for human pheromones began in the 1950s. Over the decades, researchers focused their attention on two steroid molecules, androstadienone and estratetraenol. These chemicals are closely related to male and female sex hormones and can be found in bodily fluids like human sweat. A flurry of experiments in the early 2000s seemed to suggest that they sway people's judgements of qualities like dominance or fertility – both of which might have been important for sexual success in our evolutionary past.

Definitive evidence of human pheromones is still lacking, with many conflicting findings. That is partly a result of science's "replication crisis" – whereby it was discovered that the results of many experiments were impossible to reproduce. Many of the studies on human pheromones had used small numbers of people, for ›

example, which could have created false positive results that disappear under further scrutiny. Such concerns make it hard to draw strong conclusions from historic research, but newer findings seem to be resurrecting the case.

In 2014, for instance, Wen Zhou at the Chinese Academy of Sciences and his colleagues devised a clever experiment to test the effects of androstadienone and estratetraenol on perceptions of gender. The participants watched videos of moving dots arranged to look like a human walking, then were asked to say

JANINA STEINMETZ/GETTY IMAGES

The search for sexual pheromones may be a false trail

whether they thought it was masculine or feminine. Zhou found that heterosexual men were more likely to consider the figure to be female when sniffing a solution containing estratetraenol, while heterosexual women were more likely to identify it as male when they smelt androstadienone. Interestingly, gay men responded in much the same way as straight women. (The pattern for gay or bisexual women was less clear-cut, and there was no data available for bisexual men.)

Meanwhile, Yin Wu at the Hong Kong Polytechnic University and his team recently asked 76 heterosexual men to take part in a "delayed gratification" task, in which they could either choose to see a sexually explicit picture of an attractive woman (as judged by an independent group of heterosexual men) immediately, for a small amount of time, or wait and see the image for longer. They completed 10 trials in total. Exposure to low concentrations of estratetraenol seemed to increase the participants' willingness to wait and view the sexy pictures for longer. Wu considers this to be a sign that estratetraenol increases sexual motivation among straight men.

Seventy-six participants may not seem like a large sample, but it has enough statistical power to make a false positive unlikely, which should give us more confidence in the result. Given the field's history, however, some caution is necessary. "We need more studies to replicate these findings," says Wu. He would also like to see more brain imaging experiments showing the effects of these chemicals on neural activity.

We don't know for certain whether we even have a working vomeronasal organ (VMO), which is a part of the olfactory system responsible for sensing and processing pheromones in animals. The VMO has been documented in many animals, but in humans, it isn't clear whether a rudimentary version can communicate directly with the brain through olfactory sensory neurons. There is, however, some evidence that the human VMO may have connections with underlying capillaries, which could be used to influence the hormone system. If proved true, the researchers claim it would be the first evidence of an alternative use of the VMO and could account for potential pheromone effects on human behaviour despite the absence of any sensory neurons.

For now, the jury is still out on these putative sexual pheromones. "We need more rigorous research," says S. Craig Roberts at the University of Stirling, UK. He is interested in investigating other forms of chemosensory signalling, describing our focus on sexual pheromones as a false trail. Roberts hopes to investigate whether mothers produce a chemical that helps babies find lactating breasts, for instance – which could have been far more important to the survival of our species, he says.

Whether or not pheromones exist and influence behaviour, it would seem unwise to abandon your soaps and deodorants just yet. The malodorous miasma of stale sweat will speak volumes about your personal hygiene – and that's unlikely to send many pulses racing. **DR**

WHY ARE THERE TASTE RECEPTORS IN OUR TESTICLES?

TASTE receptors might not strike you as very mysterious – they are on cells in the taste buds primarily found on your tongue and in your mouth and throat. When they bind to food molecules, they alert us to different kinds of tastes, like sweet, salty or sour.

So far, so ordinary. But in 2013, newspapers went wild over the discovery of taste receptors in our testicles. What on Earth are they doing there? Of course, TikTok has subsequently been awash with people trying to taste things with their nether regions. The truth of the matter is both less and more exciting. It turns out there are taste receptors throughout our bodies, and while they don't allow us to taste with anything other than our mouths, a better understanding of their role could lead to new ways to combat disease.

The first sign that something strange was going on came in 1996, when researchers uncovered evidence of taste receptors in the guts of rats. Subsequent studies revealed that sweet, umami and bitter taste receptors are all present in the gastrointestinal tracts of rodents and humans.

That was a bit of a surprise, but shouldn't seem too odd, says George Kyriazis at Ohio State University, "because the mouth and the tongue are part of the gastrointestinal tract".

Yet in the years since, taste receptors have popped up in organs and tissues further afield. Alongside those in the aforementioned testicles, they were also found in the heart, brain, bladder, lungs and body fat.

From an evolutionary standpoint, it would be useful for animals to develop sensors where they ingest food. This is partly to avoid eating something poisonous, but also to help their bodies respond better to what nutrients are available to them. Balanced diets would have been unlikely, says Jonathan Kirk at Loyola University Chicago. "It's like, well, today we ended up with a ton of raspberries because that's what we could

get." Animals might not encounter more berries for months, so detecting a compelling sweet taste would have helped them stay in those bushes and make the most of this short-lived bounty.

The rest of the body must also tune in to this dietary mayhem, says Kirk. Much as the taste receptors in the mouth bind to food molecules in saliva, receptors elsewhere sense what molecules are in gastric juices or the blood and respond appropriately.

Calling them taste receptors may be obscuring the bigger picture, though. The truth is that they are sensing, but we aren't tasting, so they aren't actually taste receptors. "That is the purpose that they serve on taste buds," says Kirk. Elsewhere, they are "nutrient sensors".

"The taste receptors in our testicles are sensing, but they aren't tasting"

Kyriazis says their primary role is to assess how much energy is available outside the cell and to help maintain the right metabolic environment. They do this, in many cases, by stimulating the release of calcium when they have detected a nutrient. This helps trigger a cellular response that sends a different message depending on where the receptor is.

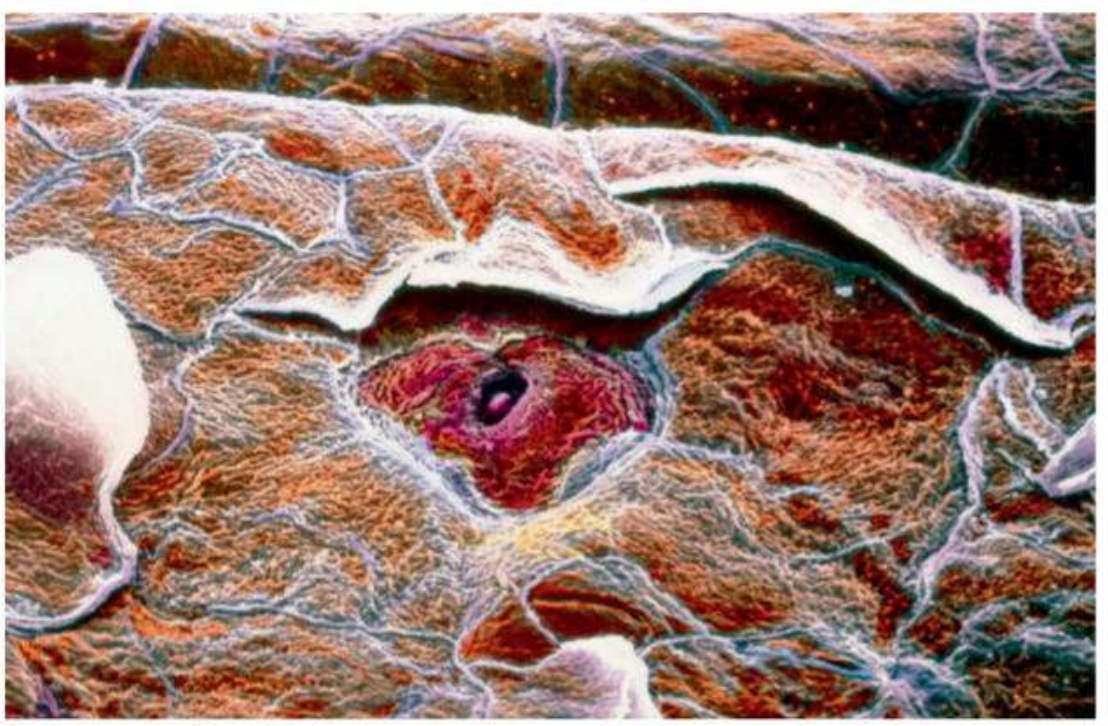
In the intestines, this message alters the behaviour of cells that absorb nutrients from food, making them more efficient, says Kirk, while his team has shown that sweet and umami nutrient receptors in the heart make the organ beat more strongly in the presence of increased nutrients. This is probably to boost the flow of blood to help cells in the gastrointestinal tract digest the food.

Meanwhile, nutrient receptors in the testicles appear similar to those involved in detecting bitter tastes in the mouth and are crucial in enabling sperm to fully develop. Mice that have had these receptors knocked out have notable reductions in sperm volume. While there isn't any direct evidence for their role in humans, there is a significant correlation between human male infertility and some alterations in taste receptor genes, suggesting this might contribute to fertility problems.

It is possible that malfunctions in our nutrient receptors have a role in other medical conditions, too. In the gut, for example, they are involved in regulating nutrient uptake and the release of molecules such as hormones and neurotransmitters that help keep organs in peak physical condition.

Disturbances to these receptors, and thus this signalling, have been

The tongue isn't the only place that taste buds like this exist



PROF. P. MOTTA/DEPT. OF ANATOMY/UNIVERSITY "LA SAPIENZA", ROME/SPL

HARRY RENDON MAYORGA/ALAMY

Other parts of our body sense sugar to aid metabolism

hypothesised as one factor influencing conditions like obesity, type-2 diabetes and irritable bowel syndrome. For instance, studies have shown an association between having fewer bitter nutrient receptors in your gut and having a higher body mass index. "Given the central role of nutrient sensing in metabolism, it makes sense that these receptors have a role in disease if they start responding abnormally," says Kirk.

All of which suggests that understanding more about their role could result in big benefits to our health. For example, when Kyriazis and his colleagues genetically eliminated sweet-sensing nutrient receptors from the skeletal muscle of mice, they found something odd. Normally, these receptors help animals move or maintain their posture. When these were knocked out in the mice, there was an increase in muscle mass and in the activity of mitochondria, the powerhouses of cells. "These mice can run faster, they have healthier muscles and they can maintain these healthier muscles during ageing," says Kyriazis.

These muscle-strengthening effects are similar to what you see happen after prolonged fasting and caloric restriction, says Kyriazis, probably because in both cases the cell is detecting much less glucose than normal. This shortage of a vital energy source prompts muscle cells to fine-tune themselves, breaking down and renewing internal structures so they function more efficiently. Perhaps one day we may be able to dial down our sweet receptors using drugs to keep muscles strong with no fasting required. At the very least, it is a tantalising taste of what might be to come. **Chris Simms**

PHOTOALTO/ALAMY

HOW MANY BLOOD TYPES ARE THERE AND DO THEY AFFECT OUR HEALTH AND PERSONALITY?

IN 2023, a paper was published in the journal *Blood* that ended a mystery stretching back four decades. It detailed the existence of a new blood type, first proposed in the 1980s – and of which there are now 45 to date.

This particular discovery was born from tragedy. A baby died suddenly shortly after birth. Its mother was subsequently discovered to have a blood type (or group) that had never been identified before, whereas the baby had inherited its father's. The two blood groups interacted in a rare way that led to a fatal inflammatory response.

It reflects a long-standing mystery of the human body – just how many blood types there really are, and how this part of our physiology will evolve in the future. We are making headway: our recently improved understanding of the differences in our blood is helping to make transfusions safer and even starting to reveal how your blood group influences your health.

Blood types are distinguished by what kind of antigens are attached to red blood cells and what kind of antibodies are in the surrounding plasma. The four most common blood groups are A, B, O and AB, which relate to combinations of antigens and antibodies, but delve a little deeper and there is astonishing complexity. Currently, the 45 blood types represent more than 390 different antigens and antibodies, with new discoveries being made all the time.

This variation is due to the ongoing battle that exists between humans and the pathogens around us, all of which would like to latch on to our red blood cells and invade our bodies. In particular, the *Plasmodium* parasites responsible for malaria are thought to have driven many of these differences. Nicole Thornton at NHS Blood and Transplant, which looks after blood donation

"Your blood type could put you at higher risk of heart disease and gastric cancers"

ARTWORK: GETTY/ALAMY

Researchers have recently discovered our 45th blood type

services in England, highlights the Duffy antigen, which can be used as an entry point by *Plasmodium* parasites, meaning that humans who have evolved with a Duffy-negative blood type are relatively resistant to malaria. "Blood group O also has a massive advantage against life-threatening malaria," says Thornton.

Other links between blood type and health have been reported – as have more spurious claims that your blood group also influences your personality and behaviour. There is bad news on the latter – contrary to what you might have heard, your blood type doesn't affect your sexual prowess, nor is there good evidence that it is linked to personality. Claims that you should eat certain foods based on your blood type are also unproven.

However, there are several studies that suggest people without an O-group blood type are at a 12 per cent increased risk of heart disease, possibly due to factors affecting blood clotting. People with blood group A are thought to be more susceptible to gastric cancers, possibly because the *Heliobacter pylori* bacteria that drive the disease are more capable of latching onto the stomach lining. Likewise, people with blood group O appear to be more protected against both gastric and pancreatic cancers. Other links will no doubt be discovered in time.

With the decreasing cost of genetic analysis, it will soon be possible for everyone to have their blood group profiled and stored on their mobile phone, predicts Connie Westhoff at New York Blood Center. "It's the next frontier for blood transfusion," she says. "There's 11 or 12 different antigens which are the most likely to cause a negative outcome with a transfusion, so people will be able to be precisely matched for those." But it will inevitably be an ongoing race to perfect this knowledge. "We're always going to discover new blood groups because humans evolve, and we change," says Thornton. "As a species, being different and having diversity is absolutely key to our survival." ▮

David Cox

Jobs

NewScientist

2024 Global Salary Survey

New Scientist Jobs, in association with SRG, is conducting its global salary, employment and industry survey (Life Sciences, Clinical and Engineering) to provide you with the latest insights, and we would love your thoughts and feedback. As a thank you, all respondents who complete the survey will be entered into a prize draw to win one of three £150 Amazon vouchers (or local equivalent).

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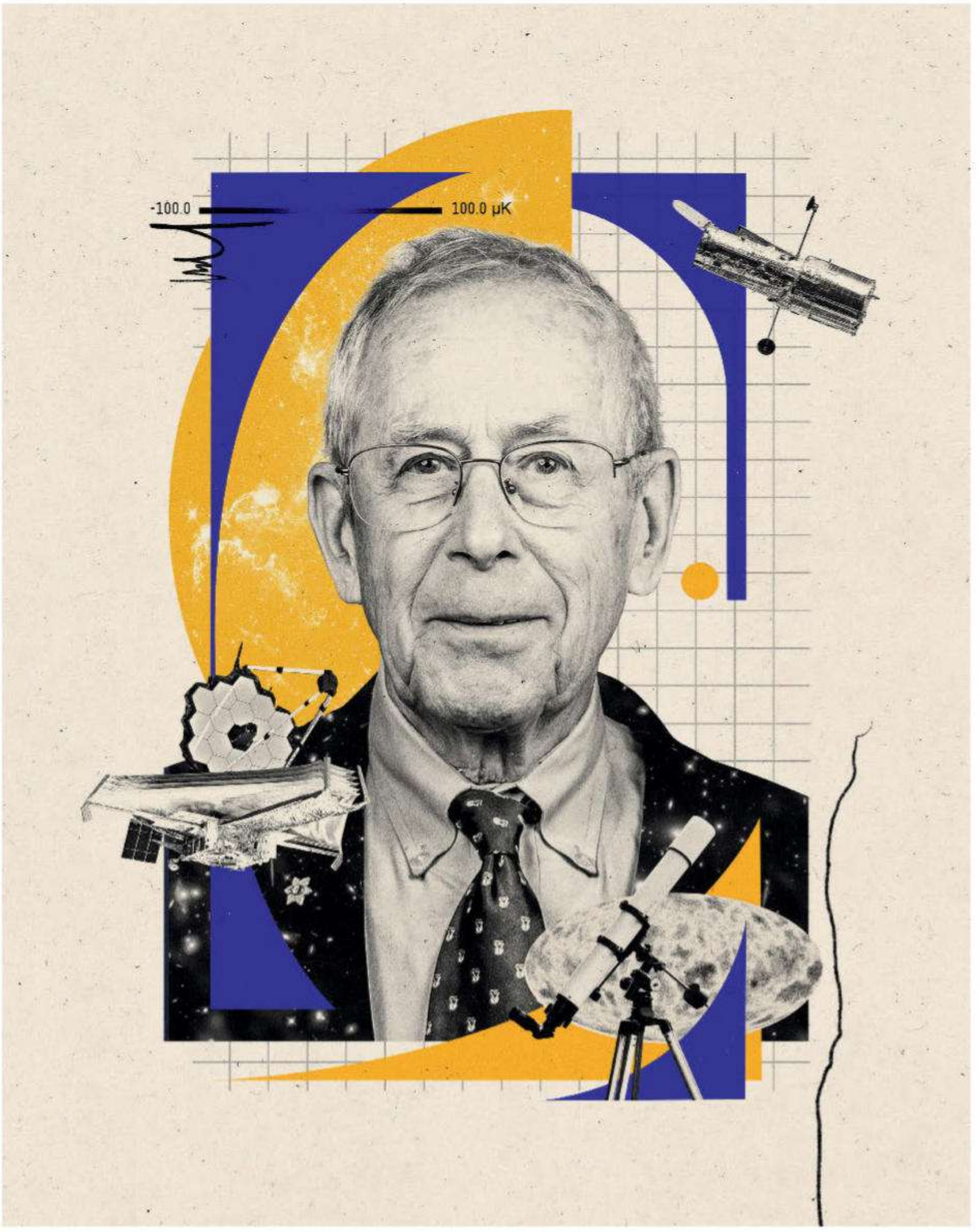


KLAWE RZECZY; ESA/NASA

‘The current situation is a golden opportunity’

Our model of the evolution of the universe is an amazing achievement. But astronomical anomalies point the way to a deeper theory, if not a complete one, cosmologist **Jim Peebles** tells Michael Brooks

JIM PEEBLES is widely known as the architect of modern cosmology – and its nice-guy-in-chief. Awarding his half-share of the 2019 Nobel prize for physics, the committee said he “took on the cosmos”, helping to create a framework now considered “the foundation of our modern understanding of the universe’s history”, known as the standard model of cosmology. Others have described him as “an extraordinary physicist”, and “uncommonly thoughtful, gracious and kind”.

Now the Albert Einstein Professor of Science, emeritus, at Princeton University, Peebles’s career began there in the 1960s, focusing on Einstein’s general relativity, which casts gravity as the result of mass warping space-time. He later worked out the characteristics of cosmic microwave background (CMB) radiation, the “echo” of the big bang, whose discovery made cosmology an experimental science. He also showed that dark matter haloes around galaxies would create a mass distribution that matched astronomers’ observations, and persuaded the field that our description of the cosmos needed to reinstate Einstein’s much-derided cosmological constant. This was originally stuck into the equations of general relativity as an awkward fudge, but we now think of it as dark energy, the repulsive force driving the universe’s accelerating expansion.

Despite the success of the standard cosmological model, Peebles has always sought to undermine it. In the past few years, he has been musing on astronomical anomalies – observations of weird galaxies and other curious phenomena – that might expose flaws in our thinking.

He tells *New Scientist* about his vision for cosmology, why it is important to stray from the mainstream and whether it is really worth pursuing a theory of everything.

Michael Brooks: When you said that a proper explanation of the evolution of the cosmos needed both dark matter and dark energy, were you aware of how important they might become?
Jim Peebles: Not at all. They were just sensible guesses about how the data might be reconciled with what we had in the way of theory. In the 1990s, most people, including me, felt that the most sensible, elegant universe would not have Einstein’s cosmological constant. Einstein didn’t like it. Particle physicists didn’t like it.

However, the evidence said that the mass density of the universe is too low compared to what is required from the expansion rate we have measured unless we add in Einstein’s cosmological constant. So I felt it was worth considering. The community had to be dragged kicking and screaming into acceptance that we must learn to live with lambda [the Greek letter that denotes the cosmological constant in the standard model of cosmology, which also includes dark matter]. I remember well one then-very-young theorist saying: “You’re only doing this to annoy us!”

Are you concerned that we haven’t yet identified the true nature of dark matter, whether that is a particle or a whole range of them?
No, I’m completely comfortable with it. We don’t have a guarantee that dark matter ever will be detected directly, and the wonderful successes of cosmology are saying that we’re on the right track and that this track requires dark matter to exist.

That said, I do think we need a better understanding. In the standard ›

"It's a challenge to be iconoclastic and also not nutty"

computations, dark matter is treated as a nearly collision-less gas of particles. That was the original idea that I introduced back in the 1980s, and it certainly works pretty well, but I introduced it with the simplest properties that I could get away with. To me, it is just crazy to think that the dark matter, which accounts for some 27 per cent of the universe's mass, is so simple. The physics of the matter we can observe is really very complicated. Surely this dark matter is more interesting than that?

So I expect there will be a great discovery, maybe triggered by the discovery of a better explanation for the way galaxies form, maybe some other way. But it will show us that the dark sector – dark matter and dark energy – is more interesting.

Some people talk of a crisis in cosmology because of the mystery surrounding dark energy and dark matter. There is also the Hubble tension, where different ways of measuring the expansion rate of the universe, known as the Hubble constant, give different answers. What do you make of anomalies like these?

I am deeply amazed at how well cosmology has done since I started working on this in the mid-1960s. We never had a guarantee we would get as far as we did, and there's no guarantee that we can continue making great discovery after great discovery. But I see the current situation as a golden opportunity. There are lots of anomalies, but the promise is amazing. We are going after well-defined problems: detect the dark matter; detect more evidence of the dark energy; detect the way galaxies form and evolve.

On the Hubble tension, I've been conditioned by the fact that, through most of my career, the Hubble constant has been a really difficult problem – and we've done well with it! We have two very different measurements relating to what has happened since the universe was one-thousandth of its present size, and they give consistent results to around 10 per cent [of one another]. To me, wow, that's wonderful! But of course, that 10 per cent is important.

My gut says the tension between the two results is to do with some systematic error in the way people reckon the distances of galaxies. But maybe the issue is a hint towards something we need to improve in our theory. There are other predictions in that same nature. The big hope, to my mind, is that other anomalies will appear.

You mentioned this in a paper you published in 2022, saying that not enough attention is being paid to anomalies in cosmology. What are the ones that interest you most?

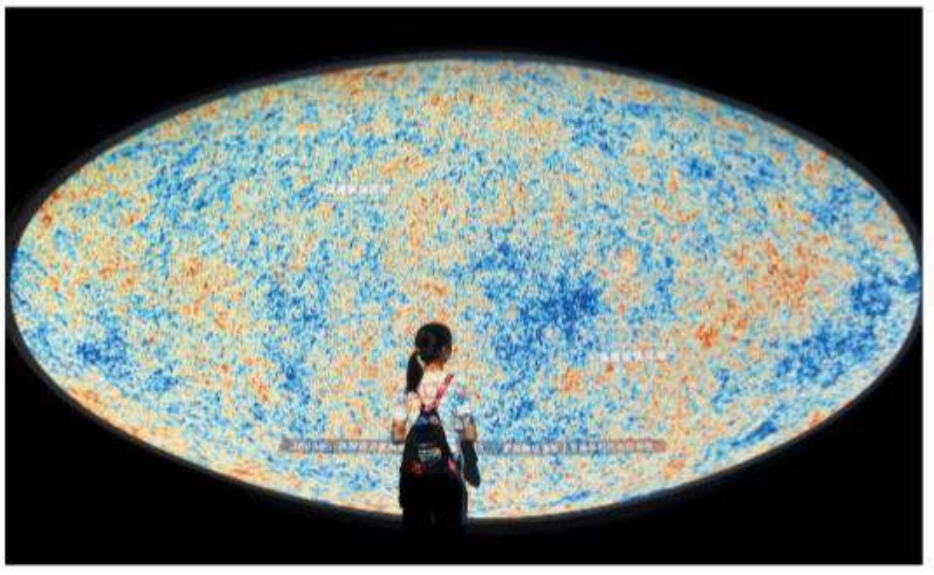
Well, there's the bulk flow anomaly: our entire galaxy is moving through this sea of radiation with a well-measured speed and direction. In the standard theory, we're moving because of the gravitational pull of some fluctuation from uniformity [in the distribution of matter in the universe]. But it's not pulling us in the direction that you would expect.

The community is pretty sure that this is some kind of systematic measurement error. It's very hard to measure the large-scale fluctuations, the departures from homogeneity that would pull on us most strongly. That said, there is a small subset of the community who have worked very hard to take account of the uncertainties, including people whose opinion I particularly respect, and if the anomaly really is there, then it's exciting because it could be a hint about the initial conditions of the universe.

The void anomaly is another really curious phenomenon. We are on the edge of a void, that is to say a region that has very few objects in it. You would expect dwarf galaxies in voids in greater abundance than we observe. And you would not expect large spiral galaxies like ours in a void, but there are a few. It just doesn't seem to hang together. That suggests we don't have quite the right theory about the material from which galaxies are made, which of course includes dark matter.

The formation of galaxies certainly has a bearing on dark matter. If we take the standard cosmology we have now as initial conditions and follow the evolution of the distribution of matter as it coalesces into galaxies of stars, it seems to me that certain aspects of nearby galaxies do not fit with results. The exact

NASA, ESA, CFHT, CXO, M.J. JEE (UC DAVIS); A. MAHDAVI (SFSU)



FEATURE CHINA/FUTURE PUBLISHING VIA GETTY IMAGES

The cosmic microwave background tells us about the early universe

Galaxy cluster Abell 520, with hot gas falsely coloured in green and dark matter in blue

means by which galactic structure first forms, the way stellar velocities appear to be dispersed within the galaxies, the origin of supermassive black holes – these and other observations are all not yet fully explained by the standard cosmology. But things like the James Webb Space Telescope are extremely promising: it's teaching us new things about the way galaxies form, and that's eventually going to inform us about the nature of dark matter.

What about modified gravity theories such as modified Newtonian dynamics (MOND) – which alters Isaac Newton's law of universal gravitation in a way that changes the strength of gravitational attraction between two masses over cosmological scales. Can they provide an answer to the dark matter problem?
Well, I have to be polite, because some people who I respect have signed on to it, but I can see no hope for MOND. If you had only galaxies to think about, you would certainly take MOND seriously. But you don't have only that: you have tests on larger scales that make wonderfully demanding predictions with great precision. Those predictions depend on the presence of dark matter. If you don't have the dark matter and you instead have MOND, how in the world could those predictions have worked so well?

Can researchers investigate these anomalies without risking damage to their reputation?
You do have to be very careful about this, because it's a challenge to be both iconoclastic and not nutty. But I think that, in cosmology, there is a slight underemphasis on small projects that look outside of mainstream research. My recommendation for people doing observational cosmology is to pay more attention to slightly iconoclastic ideas, but don't go over the rails. Look into some of these odd properties and explore why they don't fall in line so neatly with the standard theory – but maybe only if you have tenure!

I guess one could say this was exactly what you did. Was that a deliberate strategy or did you fall into it by accident?
I was in the right place at the right time. I came to Princeton thinking I would do theoretical particle physics, but, by good fortune, I wandered into the research group run by Bob Dicke. He had decided that gravity was not receiving the attention it deserved, because the classical pre-war experiments had been done and it was hard to see how they could be done better. He realised that the technology that had been developed during the second world war, and improved after the war, made it possible to redo the old experiments better and to do new experiments. So he started a wonderful programme that tested all aspects of gravity physics. It was a fascinating time.

Recently, you have been looking back at your career and have composed a forthcoming paper entitled a "physicist's philosophy of physics". Do you wish you'd had something like that at the start of your career?
No, I think it would just have made me self-conscious! I only became fascinated with this in later life – you tend to ask yourself, what have I been doing? And I've decided I've been doing something philosophically interesting. I'm an odd sort of physicist: I'm not really a theorist of any merit, and I'm not really an experimentalist of any ability. One of my earliest memories is throwing a tantrum because I could not put the coffee percolator back together, having taken it apart. I loved that sort of thing, small things that I could get my hands on and try to understand.

I think that's still my characteristic. I'm pretty good with my hands, but I've never been at a telescope when it was being used for something productive. I'm more of an intuitive thinker. In the end, my philosophy is pretty simple-minded: do what interests you, but make sure you keep in close contact with physical phenomena.

One of the questions you ask in your philosophy is whether it is worth pursuing a theory of everything. What is your conclusion?
I have become fascinated with this. I have often wondered why we assume that the universe operates by rules that we can understand. But the truth is, we have a few clues that nature has given us this wonderful gift.

For me, physics can be said to have begun when people first traced the motions of the stars and planets. They could see that the motions of the planets were not obviously simple, but they were regular. Thousands of years ago, people could predict the timings of solar eclipses well ahead of time. That predictability is now, I think, at the very heart of what we do: we try to create a theory that predicts many things that were not anticipated. If successful, that tells us that the theory is a pretty good approximation to reality. That's the whole thesis really.

While the best of our physical theories are really excellent – wonderfully predictive – not one of them is complete. When applied in the wrong situation, they fail. That's just the way it is. So it's pretty clear, I think, that physics has no guarantee of arriving at a final theory.

Instead, my bet is it's going to be successive approximations to reality all the way down. You'll do better and better, but you'll never get there. Because to get there, in my world view, you have to have experimental checks of predictions, and experiments are finite: they cannot explore all eventualities to all accuracy. So my conclusion is that we'll never get there. ▮

Michael Brooks is a *New Scientist* consultant. His latest book is *The Maths that Made Us*

The back pages

Puzzles
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***Almost* the last word**
What triggers cicadas to chirp in unison, then go silent? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
On the chopping block, and a lot to stomach p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

The science of cooking

Warm and fluffy inside

Tired of your American-style pancakes looking flat and anaemic? **Catherine de Lange** finds the secret to thick, pillowy perfection

Catherine de Lange is the editor of *New Scientist* and an avid baker. She knows pancakes aren't strictly speaking baking, but is moving house so has no oven this week

What you need

280 g (2⅓ cups) all-purpose flour
1 teaspoon baking powder
1/2 teaspoon bicarbonate of soda (baking soda)
1 teaspoon salt
1 tablespoon sugar
2 large eggs, separated
360 ml (1½ cups) buttermilk
4 tablespoons unsalted butter
Toppings of your choice

The science of baking appears every month. Share your baking successes with us on X and Instagram @newscientist, using the hashtag #NewScientistBaking

Next week

60-second psychology

OVER the holidays, I went to visit my brother-in-law, who wowed us with some exceptional American-style pancakes. Thick and fluffy, airy and nicely browned, they were a triumph, after which my children have never looked at my own pancakes the same way.

Usually, I mix up a batch of dry ingredients – flour, sugar, baking powder and bicarbonate of soda – and store until a pancake emergency arises. I then whisk in the wet ingredients: an egg, milk and some melted butter, and off to the pan we go. They taste good enough, but are flat compared with my brother-in-law's big fat pillows. So I asked him his secret.

It turns out that much of my problem came down to my raising agent. Somewhat embarrassingly for someone who loves to bake, I realised I have never fully understood the difference between the ones I keep in my cupboard: baking powder, bicarbonate of soda (or baking soda) and cream of tartar.

Bicarb is made of sodium bicarbonate and is a pure raising agent. It is used in recipes that involve acidic ingredients (think lemon juice or buttermilk). When dissolved in a liquid, the bicarb reacts with acid to create sodium, water and carbon dioxide. When heated, CO_2 bubbles expand, causing the bake to rise.

Baking powder bypasses the need for an acid in the recipe by combining bicarb with powdered acid. When dissolved in a liquid, the acid and the bicarb react to form those essential CO_2 bubbles.

VLADISLAVNOSEEK/SHUTTERSTOCK

As for cream of tartar, it is basically just a powdered acid and can be mixed with bicarb to make baking powder.

In my old recipe, the only acid is that in the baking powder, which explains the minimal rise. My brother-in-law found his recipe in a book called *The Food Lab: Better cooking through science* by J. Kenji López-Alt. Crucially, it uses buttermilk, which contains acidic bacteria. With more acid to react to the bicarb, you get more CO_2 and a better rise.

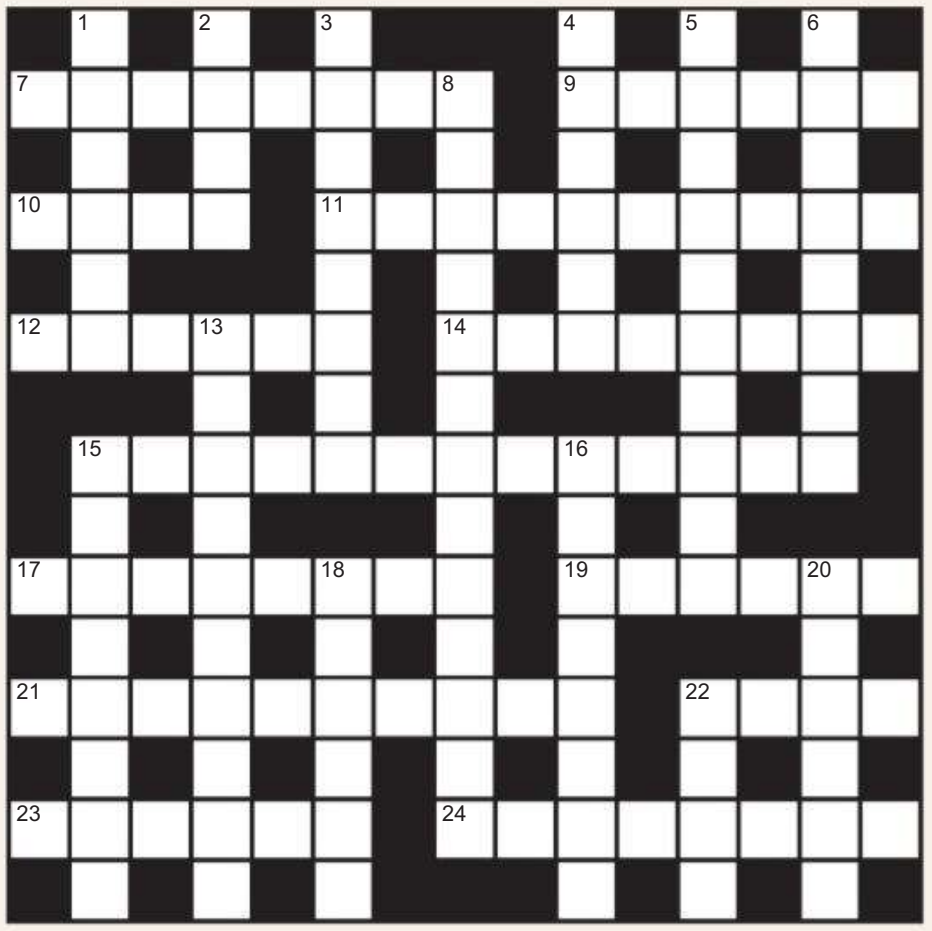
López-Alt points out that the bicarb also helps achieve the Maillard reaction, which produces aromatic compounds and a browning effect. This gives his pancakes more colour and flavour. Helpfully, he has carried out a rigorous test to find the right amount of bicarb to pull this off (see ingredients list).

Finally, if you really want a good rise to your batter, don't just chuck in the eggs like I have been doing. Separate them and whisk the whites into stiff peaks. As you whisk, the proteins in the egg form new configurations, trapping air as they go. The yolks help the batter set during cooking. Whisk them up in another bowl with the wet ingredients before carefully folding in the whites. Then fold this mix into your dry ingredients.

Dollop onto a pan heated over a medium heat, and cook for 2 minutes on each side. Add your choice of toppings, and enjoy. ▮

These articles are posted each week at newscientist.com/maker

Quick crossword #150 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

7 Chronic vitamin B1 deficiency (8)
9 Facilitating travel in a single direction (3-3)
10 β (4)
11 Lemur island (10)
12 Sinew (6)
14 Se (8)
15 Wave frequency phenomenon first described in 1842 (7,6)
17 Plans; patterns (8)
19 Sign out (3,3)
21 Taxonomic rank (10)
22 Opening; indentation; burrow (4)
23 Nearly (6)
24 Wildflower in the genus *Linaria* (8)

DOWN

1 Of a flight, overnight (3-3)
2 Compulsive appetite for non-foods (4)
3 Endpoint of a conductor (8)
4 10^{100} (6)
5 Werner ___, physicist who originated the uncertainty principle (10)
6 Slingshot or trebuchet, perhaps (8)
8 Investor in infrastructure, manufacturing, etc. (13)
13 Low point (10)
15 Separate (8)
16 Rock-forming tectosilicate mineral (8)
18 Notifications; warnings (6)
20 Tube-nosed seabird (6)
22 High-fidelity (2-2)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #236
set by Bethan Ackerley

1 What is it called when certain plants of the same species in a given area synchronise and produce an abundance of seeds periodically?

2 Bosons with a spin value of 0 are known as what?

3 The branch of finite geometry concerned with algebraic and analytic geometry over a finite field is named after which French mathematician?

4 Rickets is caused by a deficiency of which vitamin?

5 The feather-like gill that many molluscs use to respire is known as what?

Answers on page 47

BrainTwister
set by Katie Steckles
#4 Addition subtraction

It is true that 1 + 2 + 3 = 3 + 2 + 1, and the equation remains true if you remove two of the plus symbols: 1 + 23 = 3 + 21.

Starting from the equation 1 + 2 + 3 + 4 = 4 + 3 + 2 + 1, delete three of the plus symbols so the equation is still true.

Can you find a way to do the same for 1 + 2 + 3 + 4 + 5 = 5 + 4 + 3 + 2 + 1, but this time by removing a different set of three pluses than you did in the previous case?

Solution next week

Sound of the summer

What triggers cicadas to make noises in unison, then go silent periodically?

Guy Cox
Sydney, Australia
Male cicadas sing to attract mates, and the Australian greengrocer is reputedly the loudest of them all. The problem is that this also attracts birds, for whom a cicada would be a tasty meal. The insects have therefore evolved to all sing together. Any passing birds are confused and don't know where to go, but a female cicada can still identify a nearby male. As for why they stop, I guess it is when a sufficient number are otherwise engaged! Once again, it is bad news to be the last singer.

Mike Follows
Sutton Coldfield, West Midlands, UK
The males of some species synchronise their singing when there are several of them in a given area, though they don't start or stop simultaneously. Each species has its own song and singing together might be a strategy to attract more females from a bigger area, as the louder sound travels further. If they didn't

"When a cicada detects a predator, it sings more quietly or stops, in the hope the hunter is attracted to a neighbouring cicada"

sing together, it might be more difficult for females to discern the song signalling their species.

There are more than 3000 species of cicada and they spend most of their lives underground as nymphs, emerging for a few weeks of adult life.

The males of most species use an organ in their abdomen called a tymbal to sing. This includes a pair of ribbed membranes that they flex rapidly, with the resulting vibrations producing sound. Both sexes have tympana, which serve as ears. To avoid deafening themselves, the males switch off their ears while singing. They emit some of the loudest sounds of any insect.

Singing in unison is unlikely to deter predatory birds, as some have suggested. When a cicada detects a predator nearby, it sings more quietly or stops altogether in the hope the hunter is attracted to a neighbouring cicada.

The cicada belongs to a division of insects called the Neoptera, which includes most of the winged insects. Neoptera also includes other "singing" insects like the cricket. Crickets are interesting because of Amos Dolbear's eponymous law, which he devised in 1897 to describe how they can be used as thermometers. A shortcut method is to count the number of chirps you hear in 8 seconds and then add 5 to get a temperature in degrees Celsius.

[*Ed's note: This year will see two broods of periodical cicadas, Broods XIII and XIX, emerge in the US. This is the first time the two broods, which emerge every 17 and 13 years respectively, have coincided in 221 years.*]

FONS VERMEULEN/SHUTTERSTOCK

This week's new questions

Going naked **Why aren't humans covered in hair like other primates are?** ***Charles Joynson****, Rayleigh, Essex, UK*

Sense of direction **How did Roman road builders know which way to go? If they were a few degrees out setting off from, say, Chichester, they could have ended up in what is now Slough, not London.** ***Derek Peters****, Waddesdon, Buckinghamshire, UK*

Up and down

Do people who live in hilly towns have better health than those who live in flat towns?

Mark Thompson
Tewkesbury, Gloucestershire, UK
If we look at the Flogas survey of the healthiest places in the UK, then first place goes to Milton Keynes, which is flat. Second place goes to Brighton and Hove (despite being on the coast, the city is quite hilly); joint third to Swansea and Middlesbrough (both hilly and on the coast); fifth to Sunderland (mostly hilly and also on the coast); and sixth to Plymouth (again, despite being on the coast, the town is quite hilly).

So, while Milton Keynes is an outlier, the others have pseudo-challenging terrains, but are also on the coast. As my paternal grandmother used to say: "Get some sea air into your lungs, it will do you the world of good."

Pamela Ross
Findochty, Moray, UK
I lived for decades in a rather flat area of the Vale of York, UK, not a hill in sight, but moved to a seaside village in Scotland six years ago.

The village has steep hills linking the various levels from the harbour up to the "top road", including a steep hill from the end of my road down to the harbour. When I first moved here, I had to think twice about going down to the harbour as, on the walk back, I would have to stop halfway up the hill to catch my breath. After six years of regularly climbing that hill, it is no longer a problem. I don't have to stop, just keep plodding along to the top. I am not sure if that is an indication of better health or just better fitness.

Hillary Shaw
Newport, Shropshire, UK
Having researched diet and so-called food deserts – areas where there are barriers to a healthy diet (in terms of money, knowledge and accessing the food) – hilly towns may engender a worse diet, which is crucial to health.

Firstly, they may be smaller, with less access to cheap supermarkets. The Welsh Valleys were an acute case of this: some homes were 100 metres vertically

Why is it that other primates are almost entirely covered in hair, but humans aren't?

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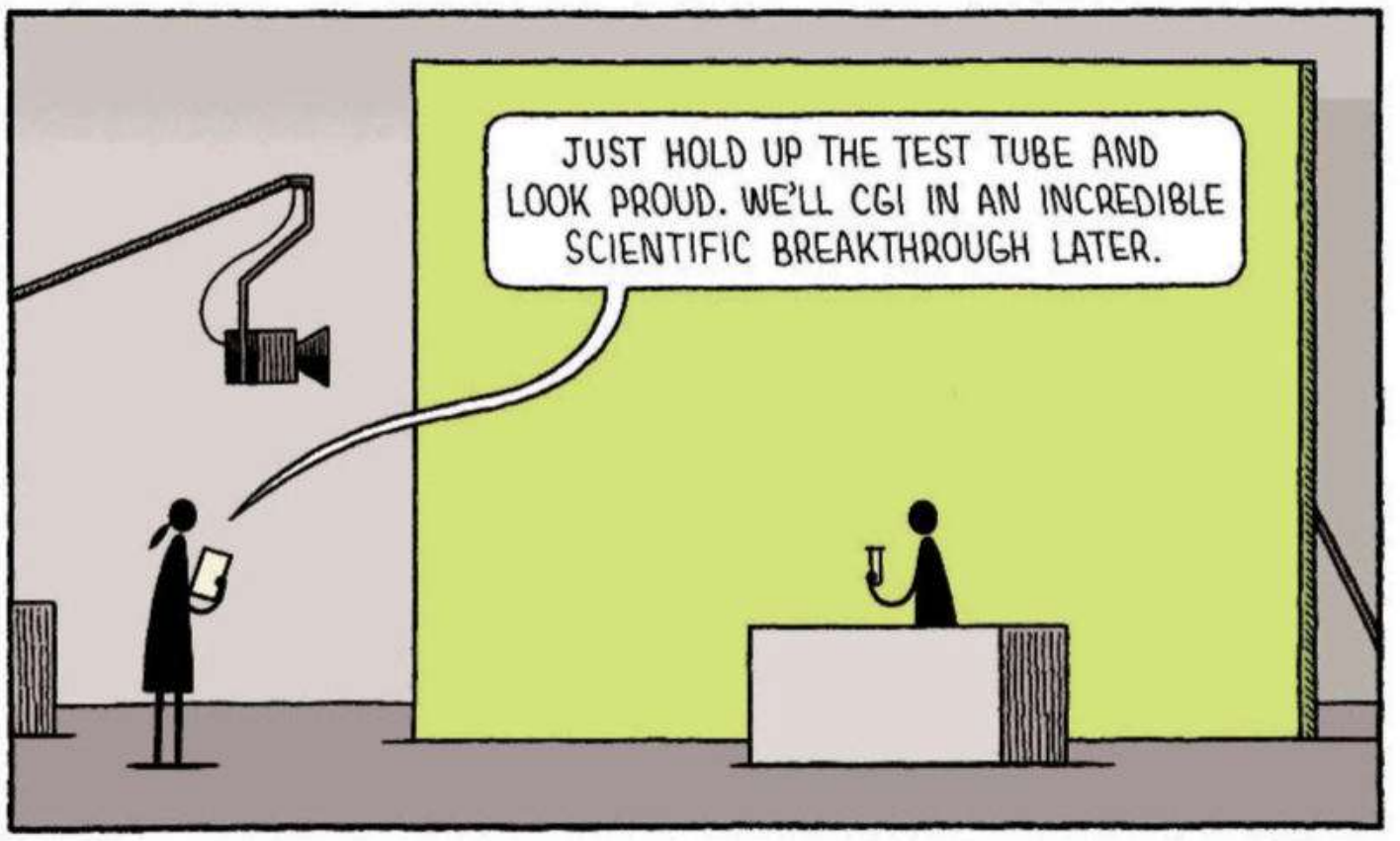
Tom Gauld
for New Scientist



above the main road with the bus stop and shops, encouraging the use of local takeaways and small shops with no fresh produce, rather than lugging heavy fresh produce uphill. Hilly towns may offer less access to other retail areas. The Welsh Valleys had towns in the next valley that were half an hour's drive away.

Secondly, hilly towns may be poorer (industry likes flat, accessible areas; big supermarkets definitely do, as they need large, flat car parks) or may be touristy, with food shops displaced by souvenir shops and cafés.

Finally, "excessive" exercise – like carrying heavy loads uphill – may cause joint wear. Against this, small hilly towns may attract an older, wealthier population with cars (young, poorer, carless people may go to big, flat cities), so they may have better cooking knowledge.

Ametrine Lavender
Hebden Bridge, West Yorkshire, UK

I live in a hillside village about 100 metres above a Pennine valley town. The 10 years I have been living here have been the fittest of my life, as I usually walk into town and back up the hill home several times a week. However, most people who live in the village use the bus or drive. It is a steep, hard walk back if you aren't fit.

"Hilly towns may be poorer: industry likes flat, accessible areas and big supermarkets need large, flat car parks"

I have talked to a number of people over the years who said they tried walking back up the hill when they first moved here, then decided never again. My response is that unless you do it often enough to get fit and stay fit, it is going to feel like hell.

We have amazing Pennine scenery here, which I enjoy very much when I am walking up and down the hill. But we also have Yorkshire weather, which puts people off walking.

You would expect that where people walk the hills, they would be fitter, but if the terrain and the weather put them off and if there is a good bus service like we have, then they may be less fit than people who walk 10 minutes on flat ground to the shops and 10 minutes back with their shopping a few times a week.

When we were having major gas works and buses were diverted, more people walked both ways. So, ironically, reducing bus services might improve health for many, unless they just revert to cars.

Snap, crackle, pop

How can popped knuckles be so exceptionally loud? (continued)

Tim Lewis
Landshipping, Pembrokeshire, UK

Donald Unger won an Ig Nobel prize in 2009 for his study "Does knuckle cracking lead to arthritis of the fingers?". Fifty years of research comparing the effects of cracking the knuckles of his left hand twice a day and using the right hand as a control confirmed that there were no ill effects. ▮

Answers

Quick quiz #236 *Answers*

1 Masting
2 Scalar bosons
3 Évariste Galois
4 Vitamin D
5 The ctenidium

Cryptic crossword #127 *Answers*

ACROSS 7 Mandelbrot set, **8** Lyrebird, **9** X-ray, **10** Closest, **12** Latex, **14** Knack, **16** Abalone, **19** Veto, **20** Ostracod, **22** Red blood cells

DOWN 1 Davy, **2** Udders, **3** Ellipse, **4** Erode, **5** Ataxia, **6** Cetacean, **11** Lancelet, **13** Ebb tide, **15** Crosby, **17** Leaves, **18** Colon, **21** Oily

#3 Page turner *Solution*

A book with 24 pages would need nine one-digit page numbers and 15 two-digit page numbers, making a total of 39 digits.

Generally, it is nine digits for pages 0-9, another 180 digits for pages 10-99 and then three digits per number above that (until you get to page 1000, which most books don't!).

With 183 digits, there would be 96 pages (183 - 9 leaves 174 digits from two-digit page numbers and 174/2 + 9 = 96).

A book that uses 636 digits for its page numbers would have 248 pages.

Corporate determinism

Nominative determinism occurs not just to people, but also to companies. This is evident from an Associated Press report about a lawsuit aimed at a firm named Chopt Creative Salad Company:

"The lawsuit filed Monday by Allison Cozzi of Greenwich, Connecticut, alleges that she bought a salad at a Chopt location in Mount Kisco, New York, on April 7, 2023, and realized while eating it that 'she was chewing on a portion of a human finger that had been mixed in to, and made a part of, the salad.' According to the suit, a manager at the restaurant accidentally severed a piece of her left pointer finger while chopping arugula."

This salad recipe reminds Feedback of a study published in 2020 in the *Aegaeum Journal* about the "dietary implication of miracle cereal finger millet (*Eleusine coracana*)".

The study includes a recipe for "cereal fried finger millet cutlets". Finger millet is a grain common in diets in southern India. To make cutlets, chop finger millet flour together with potatoes and spices. Fry it up, says the recipe, and serve with arugula.

Twisteddoodles *for New Scientist*

SCIENTISTS HAVE FOUND THAT THIS EVERYDAY OBJECT IS DIRTIER THAN YOUR TOILET!
NEWS
WELL THEY DIDN'T SAY THAT EXACTLY, THEY JUST SHOWED BACTERIA AND THAT'S NOT GOOD SO IT'S DIRTY... LIKE A TOILET.
NEWS
HOUSEHOLD OBJECT DIRTIER THAN A TOILET: PREPARE TO SAY "EW" WITHOUT CHANGING YOUR ATTITUDE TOWARDS IT.
@twisteddoodles

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Consideration of items sent in the post will be delayed

Troublesome sheep

Pertinent to recent discussions of whether computational image-processing systems are good at counting sheep (Feedback, 29 July 2023), a question arises: What about unruly sheep?

A study called "An image detection model for aggressive behavior of group sheep" claims victory, to a degree, in spotting troublemaking sheep.

First, it sketches some history that, in theory, begs for some especially savvy technology:

"In recent years, the demand for meat and milk products has continued to increase, resulting in the expansion of livestock breeding... Sheep aggression is one method to assess the well-being of sheep, as it can cause injury and even death... However, current sheep behavior detection methods rely primarily on manual observation, which can be inefficient and subjective. Consequently, there is a need to develop sheep aggression recognition models to improve sheep welfare".

The authors, in Shihezi and Guangzhou, China, report that their deep-learning-based method is an improvement on previous deep-learning-based methods.

They say it is good at recognising when there is aggression in a group (except for misrecognition "due to the similarities in chasing motion characteristics between courtship behavior and aggression behavior").

But they point to the difficulty of technologically fingering the difficult individuals within a group: "The primary issue with the video detection model proposed in this research is its inability to accurately locate aggressive sheep".

Spill your guts

Stomach flushing is at the heart of one of the few scientific research reports about life in San Marino. The tiny republic is landlocked in the mountains of northern Italy and is home to about 30,000 people.

"Using the harmless technique of stomach flushing," the researchers explain, "we inspected the stomach contents of 67 individuals, recognizing 1,018 prey items belonging to 28 different prey categories... Our study produced the first information [on] the dietary habits of this specific population."

Some of you may be relieved, and others disappointed, to learn that those 67 individuals are, without exception, salamanders. The study is called "First data on the consumed prey by *Speleomantes italicus* from the Republic of San Marino."

As to what food the humans of San Marino consume these days, the tourist info SanMarinoSite says: "With the abandonment of the countryside and social and economic transformations, the ancient traditions of local cuisine have been adapted to the needs of modern times."

A flush of turtles

Stomach flushing has its limits.

A 2008 experiment by scientists in Brazil and Italy tried to compare the munchies that came into turtles and what came out of those turtles. Their report about it is called "Stomach flushing vs. fecal analysis: The example of *Phrynops rufipes* (Testudines: Chelidae)".

"We successfully stomach flushed all 31 adult turtles captured and collected feces from ten of the flushed turtles," they say. "Our results show that only an integrated approach using both techniques is able to provide a comprehensive picture of [the] diet". The researchers complain, warn and brag that in this kind of analysis, things get tricky.

There can be confusion with vegetable cuisine: "The seeds of most kinds of palm trees common around streams in the area were eaten. Due to the limitations of stomach-flushing technique, palm fruits were underestimated, but they still contributed the highest volume of material flushed from the stomachs and found in the feces."

There can also be confusion with more meaty parts of a diet: "Results of our fecal samples also show a misleading proportion of seed items vs. animal items (99% of palm seed vs. 1% of animal remains of the total fecal volume)."

A lesson to be drawn from this: stomach flushing, by itself, might not bring full understanding. ▮

Marc Abrahams

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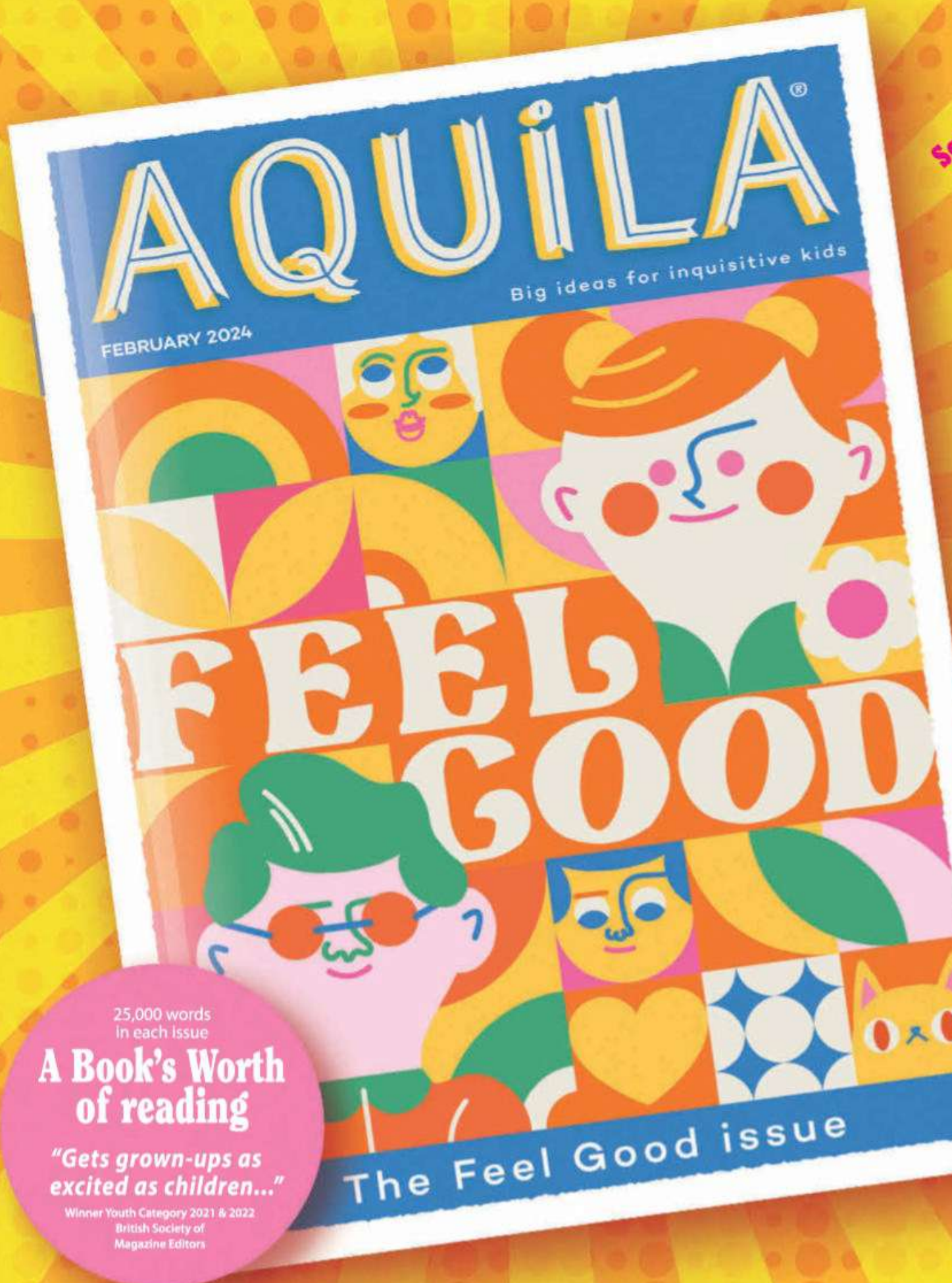

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The bliss molecule

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OMEGA innovation has reached breathless new heights for the latest update of the Speedmaster Dark Side of the Moon Apollo 8. Our tribute to the 1968 mission is built from black ceramic and features a subdial hand inspired by the Saturn V rocket. Most impressive of all, the Co-Axial Master Chronometer Calibre 3869 has been laser-ablated to represent the lunar surface with even greater definition than before. Take an orbit of this pioneering chronograph and discover state-of-the-art details with every glance.

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